# SCIENCE ABSTRACTS.

## PHYSICS AND ELECTRICAL ENGINEERING.

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## JULY 1902.

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## GENERAL PHYSICS.

**1271.** *Mercury Pumps.* **F. Neesen.** (Ann. d. Physik, 7. 3. pp. 693–697, March, 1902. Also Deutsch. Phys. Gesell., Verh., Feb. 7, 1902.)—In this paper, the author criticises the results obtained by G. W. A. Kahlbaum [see Abstract No. 1 (1902)], on the ground that the McLeod gauge was arranged near the air-pump instead of beyond the receiver. The author then describes some experiments he has made to compare Kahlbaum's pump with two single piston pumps and one double piston pump. Instead of using a McLeod gauge, six definite, luminous effects, successively obtained in a Crooke's or X-ray tube during exhaustion, are used as standards. With the double-piston pump, the X-rays appeared after 9·5 minutes pumping. This pump has a continuous action, and is provided with special valve-gear in which one "boot" empties whilst the other fills, the mercury running in from above.

C. K. F.

**1272.** *Recorder for Soundings.* **C. Bamberg.** (Zeitschr. Instrumentenk., Beib. 4. pp. 33–34, Feb. 15, 1902.)—This is a pneumatic sounding apparatus, consisting of a glass tube closed at the top by a metal cap, through which passes a capillary tube. The lower end of the glass tube is conical, and can be closed by a valve. The apparatus is protected by a casing of metal, through which holes are bored so as to give free access for water. A gauze is provided to exclude foreign particles from the capillary. This apparatus is intended to be used with a sinker, the depth being assumed proportional to the quantity of water which passes by way of the capillary into the glass tube. The glass tube is graduated to 200 m. R. A.

**1273.** *Dilatometer for extremely-dilute Solutions.* **F. Möller.** (Ann. d. Physik, 7. 2. pp. 256–284, Feb., 1902.)—The dilatometer measures the change in volume which accompanies the solution of acids or the further dilution of solutions. It was designed by the author on the suggestion of W. C. Röntgen, and is made by C. Kramer, of Freiburg, in Baden. A cylindrical glass vessel, 350 c.c. capacity, is fitted with a glass dome and a calibrated capillary. In the upper portion is suspended a tray to receive the substance; this tray is lowered by withdrawing a pin of iron, enclosed in glass, from outside with the aid of an electromagnet. The whole apparatus fits into a brass cylinder, and is kept in a water bath from which the capillary projects, and in which the apparatus is oscillated about its vertical axis. The vessel is almost filled with water, the upper portion and the capillary with petroleum. Corrections have to be made for the hydraulic pressure of the petroleum column, the wetting of the capillary by the petroleum, and the cooling which the liquid undergoes while the substance is being dissolved. These features are discussed in detail. An experiment with sodium chloride takes two minutes; very satisfactory results were obtained. H. B.

1274. *Strain produced by Gelatine.* **L. Cailletet.** (Comptes Rendus, 134. pp. 400–402, Feb. 17, 1902.)—A thick coating of strong glue spread upon glass splits off when it dries, pulling with it lamellæ of the glass, and leaving a decorative curved pattern, which is more remarkable if crystalline salts, say 6 per cent. of potash alum, are added to the glue. A cylindrical vase of thin glass so treated will split up into a hemi-cylinder; and a thick piece of glass will, under polarised light, show the contractile strain to which it is subjected. A. D.

1275. *Stresses in Plates subjected to Water Pressure.* **J. G. Boobnoff.** (Engineering, 73. pp. 390–392, March 21, 1902. Paper read before the Institution of Naval Architects.)—The outer and inner bottom plating and the bulkhead plates of a ship generally present a series of flat plates fixed to a rectangular network, and subjected to the water pressure; this pressure may be regarded as uniform for each individual rectangular plate. It is important in naval architecture to determine the relation between the water pressure, the dimensions of the plate, and the stresses produced in it. All attempts to solve the question theoretically proceed either on the assumption that the plate is absolutely stiff, or that it is absolutely flexible. The formulæ deduced on the latter assumption are in better accord with the results of experience, though it is obvious that the assumption is incorrect. The author assumes neither absolute stiffness nor absolute flexibility, and though he cannot give a definite solution he endeavours to establish the limits between which lies the tension on a flat plate of given dimensions loaded with a certain pressure; he then applies his results to the construction used in merchant vessels and in warships. A plate whose boundary is fixed resists pressure partly by its stiffness, partly by its stretching. First, therefore, the author considers the two limiting cases of the flexion of a stiff beam and the resistance of a perfectly flexible elastic chain. For a long beam supported at the ends and uniformly loaded it is well known that up to a certain limit, the strain at any point varies as the load, as also does the stress at that point; beyond that limit the strain increases faster than the load, while the stress varies almost proportionally to the load, and the beam finally breaks at its weakest part. For a chain of negligible mass stretched horizontally between two fixed points, the deflection varies as the cube root of the load, while the tension varies as the two-thirds power of the load; beyond the limits of perfect elasticity the deflection at any point increases more rapidly than before, the tension more slowly; those departures from uniformity are considerable, and the formulæ applicable to a perfectly elastic chain give neither the magnitude of the deflection nor that of the tension just before the chain breaks. In an Appendix (not reproduced in *Engineering*) formulæ are given for determining the stresses in the chain corresponding to different loads in the cases where the chain is made of ideal perfectly elastic material and of real imperfectly elastic substance; in the latter case the strains and stresses increase more slowly than the load up to the limit of proportionality, beyond that the strains increase faster than before and the stresses more slowly. The usual criterion of a factor of safety is here quite inadmissible; if a load of six tons (to take a particular chain) breaks the chain, a load of one ton produces a tension of four-sevenths of the ultimate tensile strength. The most important case in shipbuilding practice is that of a rectangular plate firmly rivetted to a frame which may be regarded as rigid, and in this case the plate represents something intermediate between the stiff beam and the flexible chain; if the tensions are small it closely resembles the stiff beam, while if they are large the chief part of the resistance of the plate is due to its extension, as in the chain. The ratio of the least dimension of the plate to its thickness determines whether the first or second case gives a closer approximation; for Seimens-Martin steel when the ratio is 20 or less, we have the first case, and when it approaches 1,000 we have the case of the chain, while for plates of medium thickness (ratio 50 to 200) the flexion is markedly different from that in the extreme cases. A table is given to illustrate this. Beyond the limit of elasticity the formulæ of the Appendix gives tensions greater than the true ones. The author considers next the cellular-bottom construction, in which the rectangular plates are not merely supported, but must be regarded as built in; he shows that if the limit of elasticity be exceeded at the built-in edges, the plate becomes a supported plate, and never regain its initial condition. The formulæ given in the Appendix enable us to calculate the limiting value of the pressure producing a permanent set of the plate, but the exact value of the breaking pressure cannot be found. The author then goes on to consider numerical values of the various quantities as they occur in marine practice, and proposes on the basis of his results a method for constructing the hull of a ship, so that the tension in the inner bottom plates when exposed to the pressure due to the test column of water (whose height must be not less than the draught of the vessel) shall not exceed the practical admitted limits, and that the tension in the outer shell plating due to the same pressure shall be as small as desired. W. S.

**1276.** *Vibrations of Two Pendulums of nearly Equal Periods on a Common Support.* **P. Furtwängler.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 12. pp. 245–253, Feb. 27, 1902.)—The knife-edges of the pendulums are parallel, the amplitudes small, and the supporting surface is assumed to experience horizontal parallel elastic displacements, whose magnitude is directly proportional to the sum of the horizontal forces exerted by the pendulums on the support. The author solves the equations of motion by introducing two complex quantities whose moduli represent the instantaneous amplitudes and arguments the phases of the two pendulums. If $V_1, V_2$ are the increases in period of the pendulums due to co-vibration of the support, then the ratio $V_1 : V_2$ is known, being $M_1h_1/T_1^2 : M_2h_2/T_2^2$ where $M_1, T_1$ are the masses and periods of pendulums and $h_1, h_2$ the distances of their centroids from the axes of rotation; in order to determine the influence of the co-vibration either $V_1$ or $V_2$ must be found. The author deduces from his results four methods of obtaining $V_1$ or $V_2$ by observation of amplitudes; three of those are virtually the same as those employed by v. Orff, Lorenzoni, and Schumann, Kühnen, and Borrass, while the last seems to be given for the first time and is applicable only to the case in which the pendulums have equal damping coefficients. He gives also a method which depends on observation of periods and which he has found easy to carry out. In the practice of this method (in which the damping coefficients and periods must be nearly equal) the pendulums are made to vibrate (1) with phases almost the same, (2) with phases almost opposite; the periods and mean phase differences are observed in the two cases. Then if $t_1, t_2$ and $1 - \epsilon$ are the periods of the pendulums and the cosine of the mean phase-difference in the first case, $t_1 - \delta_1$, $t_2 - \delta_2$ and $-1 + \zeta$ the same quantities in the second it is shown that—

$$\sqrt{V_1V_2} = (\delta_1 + \delta_2)/2(2 - \epsilon - \zeta).$$

Since $V_1/V_2$ is known, $V_1$ and $V_2$ can be found. The case of opposite phases corresponds to a method proposed by Faye for eliminating the co-vibration (Faye's double pendulum). W. S.

1277. *Forced Oscillations.* **E. Riecke.** (Phys. Zeitschr. 3. p. 130, Jan. 1, and pp. 201–202, Feb. 15, 1902.)—These are mathematical papers dealing with the oscillations of a light pendulum which is suspended from the heavy bob of another. R. S. W.

1278. *Density and Surface-Tension of Liquid Air.* **C. T. Knipp.** (Phys. Rev. 14. pp. 75–82, Feb., 1902.)—In order to investigate the surface-tension, knowledge must first be obtained as to how the density of the liquid varies with the time that has elapsed since its manufacture. This is done by the sinker method, and a curve is plotted giving density at any time. From this it is deduced that the density of freshly made liquid air is 0·933, and thereafter it increases until it reaches practically the same value as liquid oxygen. The surface-tension is investigated by the capillary tube method and also by weighing a mica frame in it. The final results show that the surface-tension of fresh liquid is between 9 and 10 dynes per cm., rising after several hours to a constant value of about 13·4. R. S. W.

1279. *Molecular Fields of Force.* **S. Leduc.** (Comptes Rendus, 134. pp. 423–425, Feb. 17, 1902.)—The application of the notion and of the mode of representation of the fields of force of Faraday to the molecular movements which take place in liquids permits the explanation of a great number of phenomena. In the case of a drop of any aqueous solution in the midst of a mass of distilled water the dissolved molecules extend by diffusion in all directions, the water moves in an opposite direction to replace them; the drop is then the seat of a field of force; the directions followed by the moving molecules being lines of force of this field. Similarly a field of force of crystallisation is got when a crystal forms itself in a solution. The dissolved molecules direct themselves to the crystal from different points of the solution, and a motion of the water in a contrary direction takes place. The case is the inverse of diffusion and the crystal is the focus of a field of force whose lines of force are the directions followed by the moving molecules. By making the molecular movements more slow by a colloid substance such as gelatine and drying rapidly the liquids operated upon, the matter has been arrested during the process of diffusion or crystallisation, and photographs of the molecular fields of force have been obtained. Examples of interference between fields of force of diffusion, or between fields of force of diffusion and crystallisation, are exhibited on some of the photographs. J. J. S.

1280. *On Universal Vibrations of Matter.* **A. Korn.** (Comptes Rendus, 134. pp. 31–33, Jan. 6, 1902.)—The principle enunciated in this paper rests on Bjerknes' experiments, and has for its object the substitution for direct action between distant bodies of mechanical forces propagated continuously through space. Ponderable matter is supposed to consist of slightly compressible particles, suspended in an infinite and theoretically incompressible ether. Such a system admits of many vibrations, capable of superposition, having periods $T_0$ $T_1$, &c., in decreasing order. Vibrations of order zero lead to the Newtonian law of attraction. Those of the first order to friction between neighbouring particles of continuous matter, which explain Maxwell's law of repulsion in gases. Vibrations of the second order lead to capillary forces, and so on. He propounds the question whether a system in which the velocities at any point in space of the above described particles are $u = \mathrm{U} \sin \frac{2\pi t}{\mathrm{T}}$, $v = \mathrm{V} \sin \frac{2\pi t}{\mathrm{T}}$, $w = \mathrm{W} \sin \frac{2\pi t}{\mathrm{T}}$, U V W being unknown functions of position, is possible. The condition that it shall be possible is that U V W are derived from a potential $\phi$ which satisfies $\Delta\phi = 0$, in free space, and $\Delta\phi + k^2\phi = 0$, in the interior of the particles. S. H. B.

**1281.** *Stability of a uniformly Rotating System.* **P. Duhem.** (Comptes Rendus, 134. pp. 23–24, Jan. 6, 1902.)—In a former memoir (Comptes Rendus, April 29, 1901), the author found a criterion of stability subject to the condition that the moment of momentum about the axis is unchanged. In the present paper he gives a criterion for a more general case as follows: If $M_0$ be a value of the moment of momentum, M any other value very near to $M_0$, then if certain conditions are fulfilled the equilibrium with $M_0$ is stable, even for disturbances which do change M. The conditions namely are (1) that for each value of M there corresponds a state of equilibrium E, in which the sum $F + \Omega + W$ in the notation of the former paper is a minimum, given M constant; (2) E varies continuously as M varies continuously. The expressions "continuously" and "minimum" require definition as follows: Suppose $dm$ an element of mass, and let $\alpha_0$, $\beta_0$, &c., be the variables which define its condition in the state of equilibrium $E_0$ of the system, $\alpha$, $\beta$, &c., the corresponding variables for the state E of equilibrium, then the state $E_0$ is infinitely near to the state E when $\alpha - \alpha_0$, $\beta - \beta_0$, &c., are infinitely small for every element $dm$ of mass, except for a certain number of such elements whose sum is infinitely small. S. H. B.

**1282.** *Boundary Conditions in Hydrodynamics.* **P. Duhem.** (Comptes Rendus, 134. pp. 149–151, Jan. 20, 1902.)—In the determination of the boundary conditions between fluid and solid, or two fluids, the author has in former works employed the principle of viscosity and the principle of friction. To the virtual work done we have to add the virtual work $d\mathfrak{T}_w$ of viscosity at contact, and $d\mathfrak{T}_\psi$ of friction at contact. And the author puts these in the form—

$$d\mathfrak{T}_w = \int f r' \partial r \, d\mathrm{S} \qquad d\mathfrak{T}_\psi = \int \mathrm{G} \frac{r'}{(r')} \partial r \, d\mathrm{S}$$

in which $r'$ is the relative velocity of two particles, one taken from each of the bodies in contact. Here $f$ and G are essentially negative, $f$ is a function of $r'$, of T the temperature at the point of contact, and of $\rho_1$, $\rho_2$ the densities in that neighbourhood. Also $d$S is an element of the interface. If $\partial x_1$, $\partial y_1$, $\partial z_1$ be the virtual displacements of one particle, $\partial x_2$, $\partial y_2$, $\partial z_2$ those of the other, and if $l$, $m$, $n$ be the direction constants of the normal to the interface, the condition—

$$l(\partial x_1 - \partial x_2) + m\,(\partial y_1 - \partial y_2) + n(\partial z_1 - \partial z_2) = 0$$

must be fulfilled. We must, therefore, add to the expression for virtual work the term—

$$w\left\{l(\partial x_1 - \partial x_2) + m(\partial y_1 - \partial y_2) + n(\partial z_1 - \partial z_2)\right\}.$$

G is then a function of T, $\rho_1$, $\rho_2$, $r'$ and $w$. He finds that if one body be a solid, then at every point on the interface—

$$l(\Pi - w) - p_{x1} = \left(f + \frac{G}{(r')}\right)(u_1 - u_2)$$

with two analogous equations, in which $\Pi$ is the pressure, $p_{x1}$, $p_{y1}$, $p_2$ are the components of the "fictive" pressure of viscosity. This determines $w$. It is necessary in certain cases to assume adhesion between solid and fluid.

S. H. B.

**1283.** *Certain Cases of Adhesion of a Viscous Liquid.* **P. Duhem.** (Comptes Rendus, 134. pp. 265–267, Feb. 3, 1902.)—This note refers to the previously mentioned case in the preceding memoir [see Abstract No. 428 (1902)] where there is adhesion between solid and fluid. He gives first the condition that the fluid may be incompressible and of uniform temperature, and supposes next the solid to have a motion of simple translation. The problem then is, given a solid cylinder of revolution about an axis parallel to $z$, moving with uniform velocity U in direction $x$, and given that it is moving in a fluid whose component velocities are $u$ $v$. Then the motion of the fluid is stationary with regard to axes attached to the cylinder, if $u$ $v$ are functions of $x - Ut, y$. If $l$ be the distance from the origin to a point in the plane of $x$ $y$, then condition (3) $lu$, $l^2\frac{du}{dx}$, and $l^2\frac{du}{dy}$ do not increase without limit as $l$ increases without limit, and the same is true of $lv$, &c. The equations of motion are, then, after Navier—

$$\frac{\partial\Delta}{\partial x} + (u - U)\frac{\partial u}{dx} + v\frac{\partial u}{\partial y} - \frac{\mu}{\rho}\Delta u = 0$$

&c., where $\Delta$ is a function of $z$. The object of the present note is to show that such a state of things cannot exist unless $U = 0$. By the equation of continuity $\frac{du}{dx} + \frac{dv}{dy} = 0$, there must therefore exist a function $\phi(x - Ut, y)$ such that $u = \frac{d\phi}{dy}$, $v = -\frac{d\phi}{dx}$. Hence he proves that $\Delta\phi = 0$, whence it follows that $u = 0$ $v = 0$. He supposes, in conclusion, a liquid of infinite extent in height and depth bounded by a cylindrical surface parallel to $z$, the velocities are independent of $z$. The liquid is infinitely extended, while the conditions (3) that $lu$, $l^2\frac{du}{dx}$, &c., remain finite while $l$ is increased indefinitely, are maintained. Then if the liquid adheres to the solid, there can be no permanent state except that of equilibrium.

S. H. B.

**1284.** *The Impossibility of Certain Permanent States in Viscous Fluids.* **P. Duhem.** (Comptes Rendus, 134. pp. 456–458, Feb. 24, 1902.)—It might be inferred from the paper considered in the preceding Abstract, the author says, that in such permanent states the fluid does not adhere to the solid. He puts a case to show that the inference is erroneous, the method used being that of Poincaré and Zaremba. There are two impossible cases, namely—1. A liquid is contained between two parallel planes of which one is at rest, and the other slides with uniform velocity parallel to itself, the liquid in the permanent state moves by layers parallel to the direction of that motion. 2. A liquid is contained between two cylinders of revolution about the same axis of indefinite extent, each cylinder having a uniform velocity of rotation about the axis. In the permanent state the liquid revolves in circles round the axis. The impossibility admits of three interpretations: *First*, That the state supposed cannot be permanent. *Second*, That there is no adhesion between fluid and solid, but only quasi-adhesion when $f$ is very great. *Third*, The equation of motion of a viscous liquid are inconsistent. He proposes to show later which interpretation should be adopted. S. H. B.

1285. *Kelvin's Images and the Equations of Elasticity.* **C. Somigliana.** (Accad. Lincei, Atti, 11. pp. 145–154, Feb. 16, 1902.)—Given an elastic medium symmetrical about the plane $z=0$, the equation of equilibrium are, in the usual rotation,

$$\frac{dX_x}{dx}+\frac{dX_y}{dy}+\frac{dX_z}{dz}=0,$$

with corresponding equations for the Y's and Z's. If $u(xyz), v(xyz), w(xyz)$ are integrals of these equations, then also $\bar{u}=u(xy-z)\, v=v(xy-z)\, u=w(xy-z)$ are integrals. If then the body be crystalline bounded by $z=0$, and has its planes of symmetry parallel to $z=0$, and if L, M, N be the forces which produce the displacement $u, v, w - L_1 - M_1 + N$ will produce displacements $\bar{u}_1, \bar{v}_1, \bar{w}$. We may now form the new integrals $u_1=u-\bar{u}$, &c., and if $L_1 M_1 N_1$ are the forces which produce them, the conditions satisfied at the boundary $z=0$ are $u_1=0$, $v_1=0$, $N_1=0$.

If we take for new integrals $u_2=u+\bar{u}$, &c., and corresponding forces $L_2 M_2 N_2$, the conditions are $w_2=0$, $L_2=0$ $M_2=0$—in the one case two tangential components of displacement and the normal component of pressure vanish, in the other two tangential components of pressure and the normal displacement. By this method is solved the following problem, to determine the deformation produced in an indefinite body, bounded by a plane and crystallised with planes of symmetry parallel to that bounding plane, when on that plane are given the tangential components of displacement and the normal pressure. Also the corresponding problem with displacement and pressure interchanged in the conditions for the bounding plane. The calculations are then applied to the case of isotropy. If there be two orthogonal planes of symmetry, for instance $x=0$, $y=0$, and if $u, v, w$ are integrals, the method above indicated enables us to deduce two other sets of integrals.

By a further extension of the method it is shown that a solution may be found of the problem of the deformation of the right diedron, solid and isotropic, so crystallised that the planes parallel to the faces are planes of symmetry, when on one face, *i.e.*, $x=0$ the components L, $v_1$, $w_1$, and on the face $y=0$ the components $u$, M, $w_1$, are given, that is on both faces the normal pressure and tangential displacements are given. And again the corresponding problem is discussed in which pressures and displacements are interchanged in the face conditions. S. H. B.

1286. *Elastic Equilibrium of Circular Cylinders under Certain Practical Systems of Load.* **L. N. G. Filon.** (Roy. Soc., Phil. Trans. 198. pp. 147–233, Feb. 28, 1902. Roy. Soc., Proc. 68. pp. 353–358, July 9, 1901. (Abstract).)—The writer objects to the solutions usually given for the extension and compression of elastic bars on the ground that they are based on the assumption that the bars are strained under normal tension or pressure uniformly distributed across the plane ends, and in like manner to the solution for torsion as assuming tangential stresses across the plane ends. These assumptions are not realised in practice. Solutions are given in this paper more in accordance with conditions occurring in practice. The writer first works out the general solution for a symmetrical strain (sections 3 and 4), using cylindrical coordinates as in Todhunter and Pearson's history of elasticity. He then applies the method to three problems. The first problem is that of a cylindrical bar of radius $a$ subjected to a determinate system of normal radial pressures and of axial shears over the curved surface, the radial pressures being symmetrical about the mid section, and the shears having their signs there changed. In a subdivision is considered the special case when the pressure is zero. The stresses on the curved surface are calculated and the numerical results discussed—sections 5–11. The second problem is that of a similar cylinder under pressure whose ends are not allowed to expand. And in this relation two methods of constraint are dealt with in sections 12 and 13 respectively. First method—(1) There is no shear $\overline{rz}$ along the curved surface $r = a$. Over two rings of breadth $e$ at the ends a radial pressure P is made to act, so adjusted that there is no radial shift at the points A, B, or C, D on the circumference at the respective plane ends. (2) The plane ends AB, CD are constrained to remain plane, and are subject to a total normal pressure $\pi a^2 Q$. The second method of constraint is effected by shear over the terminal cross-sections. In this case (1) there is a total pressure $\pi a^2 Q$ over the plane ends, the distribution being unknown; (2) the ends are constrained to remain plane; (3) the ends are not to expand along the perimeter. This condition is satisfied by allowing a shear $\overline{rz}$ over the plane ends. (4) There is no stress across the curved surface. These conditions represent the state of things when the cylinder is compressed between two rigid planes sufficiently rough to prevent expansion of the ends. In section 23 the phenomena attending rupture, the distribution of maximum stress, strain and stress difference are considered. It is found that whatever theory of yielding be adopted, viz., the greatest stress theory of Navier and Lamé, the greatest strain theory of St. Venant, or the greatest strain difference as recently put forward, failure of elasticity will begin to take place round the perimeter of the plane ends. The values of the apparent Young's modulus and Poisson's ratio are here discussed. It is inferred from the numerical calculations given that plastic deformation begins to occur round the perimeter for a stress between ⅔ and ½ of that which is required to cause a cylinder under uniform pressure to pass the elastic limit. The third problem is that of torsion. The cylinder is supposed subject to a certain series of transverse surface shears. A special case is considered where there are two discontinuous rings of shear. The general results obtained indicate that as we go away from the points of application of the stress a "uniform" solution is obtained sooner in the case of torsion than in that of either tension or pressure. S. H. B.

**1287.** *Tensions produced in the Interior of an Indefinite Solid by Two Equal and Opposite Forces.* **Mesnager.** (Comptes Rendus, 133. pp. 1286–1287, Dec. 30, 1901.)—According to the author Flamant proved that in two dimensions a pressure $p$ applied normally to a solid bounded by a line, and maintained at infinity, gives in the interior Lamé's ellipses reduced to a line equal to $-2p\cos\alpha/\pi r$ in the line joining the point of application of $p$ to the point considered. The author superposes another solid coinciding with the former, but with an applied force $f = -p$. He then says that the isostatic lines in the solid so constituted are concentric circles about the point of application of the pressure, and the tensions are constant along circles passing through the point of application and centred in the normal. He then finds, by a geometrical construction, the resultant effect at a point in the interior. If at two points A and B equal and opposite forces are applied, the isostatic surfaces are circles of the stereographic projection constructed with A and B as poles. On the circle whose diameter is A B the two principal resultant forces, defined by the author, are equal, of the same sign, and constant.

S. H. B.

1288. *Dynamical Equations of Anolonomous Systems.* **G. A. Maggi.** (Accad. Lincei, Atti, 10. pp. 287–292, Dec. 15, 1901.)—The discussion in this paper is of a material system subject to connections which may vary with the time, and of the proper form of the differential equations applicable to such a case. They were deduced from Hamilton's theorem by Kirchhoff in his Mechanik in a general form. Volterra, in the Atti delle R Accademia delle Scienze di Torino, obtained a set of equations satisfying the conditions in terms of the "characteristic" functions of the motion, and equal in number to the degrees of freedom of the system. Finally, Appell (in vol. 129 of Comptes Rendus, "On Equations Analogous to those of Lagrange," and "On a General Form of the Equations of Dynamics," Crelle's Journal, 1900) has given another solution, using the same method of the characteristic functions. The present writer treats the subject in a purely theoretical manner. He starts from Hamilton's $\int_{t}^{t'} (\partial T + \Pi)\partial t = 0$, and by the aid of Lagrange, shows how to deduce both Volterra's and Appell's forms of the general equations. In conclusion he discusses an objection raised by Appell to the general method. Appell had shown that *holonomy* is a necessary and sufficient condition for the virtual and effective motions of a system being subject to the same connections.

S. H. B.

1289. *Capillarity Constants of Crystal Faces.* **H. Hilton.** (Phil. Mag. 3. pp. 144–148, Jan., 1902.)—The author discusses a theorem of G. Wulff given in Zeitschrift f. Kryst u. Min., vol. 34, 520. According to this theory, if $k_1$, $k_2$, $k_3$, &c., be the capillarity constants on the different faces, $n_1$, $n_2$, $n_3$, &c., the normals which define the faces, the surface energy is—

$$E = p\,(k_1 n_1^2 + k_2 n_2^2 + \&c.),$$

where $p$ is a constant, and the volume is—

$$V = q\,(n_1^3 + n_2^3 + \&c.)$$

Now E must be minimum, given V. This requires that—

$$dE = 2p\,(k_1 n_1\,dn_1 + k_2 n_2\,dn_2 + \&c.) = 0$$

$$dV = 3q\,(n_1^2\,dn_1 + n_2^2\,dn_2 + \&c.) = 0,$$

which (says Wulff) cannot be unless $k_1 : k_2 : k_3 \ldots = n_1 : n_2 : n_3 \ldots$ The writer says the proof is faulty, on the ground, firstly, that the expressions for E and V should be $E = k_1 p_1 n_1^2 + k_2 p_2 n_2^2 + \&c.$,

$$V = \tfrac{1}{3}\,(p_1 n_1^3 + p_2 n_2^3 + \&c.),$$

where $p_1, p_2$, &c., are constants. This, however, does not affect the argument, because Wulff has assumed the ratios $n_1 : n_2 : n_3$, &c., constant. Secondly, because Wulff tacitly assumes $dn_1$, $dn_2$, &c., to be independent. The proof however, as the author shows, can be made good. It is proved, namely, that a point $O_1$ exists for which if $n_1$ $n_2$ be the perpendiculars on the faces, $n_1 : n_2 : n_3 \ldots = k_1 : k_2 : k_3 \ldots$ and the theorem is applied to a particular case. S. H. B.

1290. *Hecker's Determination of Gravitation on the Atlantic Ocean.* **F. R. Helmert.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 8. pp. 126–128, Feb. 13, 1902.)—Mohn having shown that mercury barometers can be corrected for gravitation by the aid of hypsometers, the author sent Hecker, in summer, 1901, on a Hamburg steamer from Lissabon to Bahia with four barometers and six hypsometers. The different instruments agreed well with one another. Gravitation seems to be normal over the deep water of the Atlantic, in accordance with Pratt's theory of isostatic stratification of the earth's crust. The Bay of Biscay appears to form a deep valley over which gravitation is less than normal. H. B.

1291. *Propagation of Earthquake Motion.* **G. Grablovitz.** (Accad. Lincei, Atti, 11. pp. 177–185, Feb. 16, 1902.)—The author distinguishes three distinct phases in earthquake movements, viz.: (1) Rapid, probably longitudinal, oscillations'; (2) slower movements of somewhat difficult interpretation; (3) much slower, probably transversal oscillations. These oscillations reach the observing instruments, in general, at different times, so that one can estimate from the interval of time between the first phase and the third the distance of the centre of disturbance. The author in this way, basing his calculations on Cancani's (fixed) velocities for the first and third phases, formerly obtained the coefficient, 300 km., for every minute's interval between the first and third phases. He now finds, from an examination of recent data, that the first phase propagates itself with varying velocity, so that the above coefficient varies from 329 at 40° distance to 260 at a distance of 120°. These considerations apply only to propagations to long distances; the author emphasises the futility, with the present chronometrically inexact seismograms, of attempting to generalise the rates of propagation over very limited areas. D. H. J.

1292. *The Hungarian Salt Lakes as Natural Heat Accumulators.* **A. v. Kalecsinsky.** (Ann. d. Physik, 7. 2. pp. 408–416, Feb., 1902. Paper presented to the Hungarian Academy of Science, Oct. 21, 1901.)—North-east of Szováta, in the Comitat of Maros-Torda, lies the Sóhát or salt ridge, with salt springs, salt rocks up to 50 m. high, little rivulets, and a number of salt lakes. In three of these, notably in the Medve Lake (average depth 10 m.), the surface temperature is approximately that of the atmosphere, but at a depth of 1·32 m. the temperature may vary between 69° C. in September and 26° C. in April; with greater depths the temperature decreases again. There are no hot springs nor any chemical processes to account for the high temperature, nor did artificial ponds, made by the author in the clay soil and filled with fresh or with salt water, show any peculiarity. But when a layer of fresh water was spread on the salt water, the higher temperatures were observed in the denser salt water. The density of the Medve water is 1·038 (3 per cent. of NaCl) at a depth of 0·1 m., and reaches 1·183 (24 per cent.) at 1·5 m. and 1·196 (25 per cent.) at 5 m. According to P. Lenard, insulation completely explains the phenomenon, and salt lakes can, therefore, be turned into heat accumulators; the slightly saline surface layer of water should not be more than 2 m. in thickness. H. B.

1293. *The Dynamics of Cyclones.* **J. Aitken.** (Roy. Soc. Edinburgh, Trans. 40. 1. pp. 131–156, 1901.)—Vortices will not occur either in air or water unless, in addition to the low pressure, there is some initial circular motion. Otherwise, the air, or water, will flow towards the low-pressure centre radially. This is illustrated by the familiar phenomenon accompanying the emptying of a basin of water by opening an orifice at its lowest point. A noteworthy feature in water vortexes so formed is a great increase in the velocity of the water as it approaches the centre of the movement. The author clearly illustrates this by means of two suspended balls capable of rotating about a common centre, and kept, by means of a cord, at a fixed distance, which can be decreased by shortening the latter. If this is done while the balls are revolving around the common centre, there is no resulting increase of energy, as the natural force is perpendicular to the direction of movement. When, however, the balls are moving in a spiral path, there is but one component of the radial force acting in the direction of the motion, which increases the velocity. The resistance offered, in the case of a cyclone, by the spirally moving air, enables the latter to develope more energy than if the air moved inwards radially, as the retardation causes a fall of pressure, and the energy of the cyclone is increased.

In an experiment in which columns of fume created by hydrochloric and ammonia rising from a table covered with a glass plate are made to ascend into a heated tube, while a rotating motion is caused by an artificial air-current passing over one portion of the area while the other is protected by a screen, the author demonstrates, among other facts, that the air near the surface of the area moves much more radially than that which is higher, and that the former is drawn into the very core of the cyclone, while the higher air forms the envelope. He then demonstrates by means of water vortexes that the tangential force not only is the cause of the rotatory movement, but that the whole low-pressure area moves in the direction of the greatest tangential force. He expresses the opinion that attention has been too much contemplated in the cyclonic area to the neglect of the equally important anti-cyclonic area. If an anti-cyclone is blowing outside a heated area, some hundreds of miles in diameter, from which columns of air are rising vertically, the upper air descending would, upon reaching the surface of the ground, spread radially over the paths were it not changed into spiral paths owing to the earth's rotation. As the air near the surface of the ground moves more radially than the upper air, the higher currents cross the lower at a greater or lesser angle, and check its rising even if lighter than the upper strata. Thus the anti-cyclone prevents the formation of local cyclones, and drives all the moist hot air to the circumference, keeping it near the ground. Hence the air in front is hotter and moister than behind. If now the hot air begins to form a cyclone outside of the anti-cyclone it has a supply of hot air collected for it by the anti-cyclone, and owes to the latter also the tangential force required for its spiral circulation. The cyclone, however, with strong winds blowing tangentially on one side, must move in the direction of these winds, and only by so doing can renew its supply of moist, hot air. The Synoptic Charts issued by the Meteorological Office support the author's theory that the tangential winds are the principal cause of the movement of the cyclone as a whole, and that the centre of depression moves in the direction of, and nearly parallel to, these winds. The part played by the anti-cyclone in the vertical circulation of our atmosphere has, according to the author, received too little attention. The effect of cold is as important in the movement of winds as the sun's heat. In summer the latter gives rise to cyclonic conditions in the air over continental areas, while in winter the earth's radiation gives rise to anti-cyclonic conditions, and is as true a cause of vertical circulation as the heating of it, though, perhaps, to a smaller extent. The lower air sent forward by the anti-cyclone is swept off its circumference by the cyclone and drawn into the cyclone, curving round the front of it, and in its passage draws with it the hot, moist air in front of the cyclone area. The author in conclusion states his reason for preferring this dynamical theory to the ordinary convectional theory. G. G.

1294. *Hail Cannonades.* **J. R. Plumandon.** (Revue Scientif. 17. pp. 174–178, Feb. 8, 1902. Report presented at the Third International Hail Defence Congress, Lyon, Nov. 15 and 17, 1901.)—Hailstorms have diminished in some districts, but there was also a decided periodical decrease in their number in the years 1886 to 1892. People speak of the conversion of hail into snow by the cannonades, though snowfalls are not in general rare with thunderstorms, and were previously known in these localities. Hail showers are, moreover, so peculiarly local that the best cases of hail stoppage and prevention are doubtful. The author advocates careful official meteorological observations and systematic distribution of the guns. At Denicée 52 guns are distributed, 500 m. apart, over a rectangular area; at St. Gengoux-le-National they are arranged along the hailstorm line; in the Beaujolais district 340 guns are stationed on 18 fields, covering 10,000 hectares. He would place the guns in long bands, normal to the narrow hailstorm bands. H. B.

1295. *Cosmogony.* **S. Arrhenius.** (Archives Néerlandaises, 6. pp. 862–873, 1901.)—In this paper the author endeavours to show that, without going beyond known natural laws, we may legitimately infer that the universe has continued without materially changed conditions for an indefinitely long time, and that it will so continue for an indefinitely long period in the future. Following Newcombe's modification of an argument by Lane as to the conditions of a mass of gas contracting under the influence of its own gravitation, the ordinary gaseous laws being supposed to hold, he shows that, for the ordinary monatomic and diatomic gases forming the bulk of the gaseous matter known to be in existence, such a mass will, before it has contracted to one-eighth of its volume, with a corresponding increase of its pressure in the ratio of 16 : 1, and a consequent doubling of its initial temperature, begin to lose heat by radiation, while continuing to rise in temperature. If the pressure increases more rapidly than this, a second stage will be reached in which the mass will be cooled by contraction; and with such gases as hydrogen and nitrogen, Amagat's investigations show that this will occur at pressures of more than 250 to 300 atmospheres at about 17° C. The densities of the nebulæ are much less than this, so that if they lose heat by radiation, their temperatures will increase more rapidly, and therefore, conversely, the communication of heat from outside will cause cooling accompanied by expansion. This expansion would continue indefinitely if it were not for bodies, such as comets and meteorites, which are aggregated by their mutual gravitation into solid nuclei around which the gases become condensed, so forming new stars, which take up the energy from the older ones as they cool down. When these latter begin to form a solid crust, the loss of energy will immediately fall to an insignificant percentage of its immediately preceding value. This third stage will therefore continue for an indefinitely long time compared with the other two, and it may therefore be inferred that the number of dark bodies in space is very much greater than that of luminous ones. Bodies in the second and third stages will contain in their interior, owing to the high temperature, only substances which are extremely stable, viz., those having great potential energy, and they will be greatly compressed. Collisions will therefore give rise to explosive outbursts of gases, and it is shown that these would give rise to spiral nebulæ, and also that the new stars forming their nuclei would show the displacement of the dark lines towards the violet end of the spectrum, and of the bright lines towards the red end, which is characteristic of those observed.

The author points out that there will be practically no dissipation of gravitational energy during expansion, and none through ordinary chemical dissociation. Some dissipation is necessary, however, to prevent the indefinite increase of entropy. This the author finds in photochemical processes forming the inverse of those which occur on the surface of the earth for example. Under these conditions, the series of changes may go on without intermission, but in order that the entropy may remain constant, the average period of the cyclical changes must ever increase, so that the quantity of nebulous material in existence must continually become greater, while that of the stars must correspondingly decrease. G. W. DE T.

1296. *Solar Theory.* **J. Halm.** (Nature, 65. pp. 351-354, Feb. 13, 1902.)—The author commences by inquiring what may be the influence on the solar atmosphere of a change in opacity or absorbing power of that atmosphere itself. Langley calculated that an increase in the absorption of the sun's atmosphere of as little as 20 per cent. would lower the mean surface temperature of our earth by at least 100° F., so that the effect of changes would be enormously greater at the surface of the sun itself. Coming next to a consideration of Helmholtz's theory, in which the heat generated by the gravitational contraction more or less compensates for the heat lost by radiation, he assumes that the sun has passed the critical stage where these two quantities are equal, and that consequently it is on the down grade with respect to temperature. Under these conditions the progressive cooling of the star would lead to the formation of an absorbing envelope above its photosphere, by which the disproportion between the generation and loss of energy would be reduced, but the gradual increase of the absorbing stratum would continue. At some time the energy reflected back to the nucleus from the layers of this stratum would, together with the contractile energy, again balance the radiation expenditure. The importance of this is seen when it is considered that when such a stage is arrived at the layer in question will afterwards become relatively overheated, and the continuance of such will ultimately give rise to such pressure that the equilibrium of the system is broken down, and a solar disturbance produced which may reach the surface of the photosphere. On developing the analytical discussion of these conditions a result is found which possibly corresponds with the known periodicity of solar phenomena. One of the most important of these is the peculiar shift of the maxima at different epochs during different solar cycles, this being accounted for by the reaction of convection disturbances on the main period of disturbance. C. P. B.

1297. *Hertzian Waves Emanating from the Sun.* **H. Deslandres and Décombe.** (Comptes Rendus, 134. pp. 527-530, March 3, 1902.)—This is a short discussion of the probability of Hertzian oscillations being emitted from the sun. The reason why all attempts to recognise such have hitherto faile may be partly due to the strong absorption by our atmosphere, and also to the proper receiving apparatus not being used. The author suggests a receiving wire parallel to the earth's axis, and provided with a triple terminal having components mutually at right angles, so as to arrest vibrations polarised in any plane. C. P. B.

1298. *The Brightness of a Star and the Moment of Perception.* **H. G. van de Sande Bakhuyzen.** (Konink. Akad. Wetensch. Amsterdam, Versl. 10. pp. 631–634, Feb. 22, 1902.)—In a previous article [see Abstract No. 817 (1902)] the author considered the influence of the brightness of a star on the time of perception of its appearance, and the bearing of those results on the variation of personal equation in transit observations. He now records similar experiments on the sudden disappearance of luminous points of varying brightness, the degree of brightness being reduced to magnitudes of stars by means of a simple device analogous to Glan's spectrophotometer.

The following table shows the relation between brightness and time of perception on appearing and disappearing :—

| Magnitude. | Personal Error on Appearing. | Personal Error on Disappearing. |
|---|---|---|
| 5·7 | 0·275secs. | 0·314secs. |
| 7·4 | 0·316 | 0·329 |
| 8·6 | 0·413 | 0·387 |
| 9·5 | 0·530 | 0·489 |

The differences of the personal error for different brightnesses are independent of the form of apparatus used. The influence of those variations of personal equation upon astronomical determinations of position and observations of covering of stars is pointed out. A. G.

1299. *Nebulosity about Nova Persei.* **G. W. Ritchey.** (Astrophys. Journ. 15. pp. 129–131, March, 1902.)—Further photographs have been obtained with the 24 in. Yerkes reflector, which show that the changes in form of the nebulous surroundings of the Nova still continue. Drawings are reproduced from five of the best negatives. The principal ring of nebulosity first detected has continued to fade rapidly, only two of the chief condensations in it being perceptible. The strong condensation close to the Nova has, however, not apparently changed in brightness since November 9, 1901, but its form shows slight expansion towards the south.

Other portions show rapid radial movement outward from the Nova. Of course the changes may not be due to an actual movement of matter, but to the successive changes of illumination of various portions of a stationary nebula. [See also Abstracts Nos. 447 and 448 (1902).] C. P. B.

1300. *Movements and Changes in Nebulosity round Nova Persei.* **C. D. Perrine.** (Astrophys. Journ. 15. pp. 136–141, March, 1902.)—The paper contains list of photographs showing the nebulosity and descriptions of the changes found on measurement. Originally the principal ring of nebulosity was not circular, but in the form of an irregular oval considerably flattened on the south-west side. The longer axis was in position 115°. Inside this was a smaller and fainter nebulous structure, almost perfectly elliptical in form. The major axis of this lay in position angle 60°, and was 2′·5 in length. The successive changes shown in the photographs are described in detail.

C. P. B.

1301. *Chemical Origin of the Spectrum Lines in Nova Persei.* **J. N. Lockyer.** (Roy. Soc., Proc. 69. pp. 354–360, March 7, 1902.)—In strong contrast with the published origins of other observers, the first stages of the Nova spectrum are here considered as chromospheric, and collateral evidence is adduced to show the coincidence of many of the principal groups with well-marked lines in the spectrum of *a* Cygni, which recent work at Kensington shows to be due to the "enhanced" type of metallic spectra. Moreover, in the star *η* Argus we have a constant spectrum of very similar constitution to the temporary one exhibited by the Nova Persei.

Tables of the wave-lengths and probable origins of the lines measured from photographs are given, with comparison values given by Campbell and Vogel. The substances indicated as present are Ca, Fe, Ni, Ti, Sr, Si, Sc, Cr, and Mg, all in the *proto-* or enhanced form. [See also Abstracts Nos. 20 and 447 (1902).] C. P. B.

1302. *The Flash Spectrum.* **S. A. Mitchell.** (Astrophys. Journ. 15. pp. 97–121, March, 1902.)—The paper contains the results of photographic observations of the total solar eclipse of May 18, 1901, taken in Sumatra. Two instruments were set up—a telescope used to photograph the corona and a spectroscope consisting of a flat Rowland grating and quartz lenses. With this instrument eight films were exposed, and of these two for the flash spectrum. The clouds seriously interfered with the observations, but the negative of the second flash was good though not in perfect focus. A table is given of the wave-lengths obtained from this film between the limits $\lambda = 4924$ to $\lambda = 3835$. The author divides the flash lines into three groups: (1) Lines strong in flash and in the solar spectrum; (2) lines strong in flash and weak in the solar spectrum; (3) lines weak in flash and strong in the solar spectrum. This grouping of lines is identical with that adopted by Evershed from his observations on the Indian eclipse. [See Abstract No. 294 (1902).] By measuring the angular extent of the bright arcs an approximate estimate of the depths of the layers of the different elements was formed, and they vary from 8″ for hydrogen to 0·5″ for iron. The author disagrees with Lockyer's theory (see preceding Abstract) that enhanced lines are especially evident in the flash, because an enhanced line with no solar counterpart is not to be found in the flash, and, further, all the enhanced lines which do appear in the flash are strongly in evidence in the solar spectrum. E. C. C. B.

1303. *Velocities of Gas Nebulæ.* **J. Hartmann.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 12. pp. 237–244, Feb. 27, 1902.)—The paper describes spectrographic measurements carried out on the nebulæ G.C. 4390, 4373, and N.G.C. 7027. In the case of the first nebula the hydrogen lines $H\beta$ and $H\gamma$ were measured, and from the values obtained the velocity of the nebula was calculated. Corrections were then applied to the wave-lengths of the two nebula lines $N_1$ and $N_2$, and the final numbers are $\lambda = 5007{\cdot}04$ and $4959{\cdot}17$. Keeler's measurements of the wave-lengths of the same lines in the Orion nebula were $5007{\cdot}05 \pm 0{\cdot}03$ and $4959{\cdot}02 \pm 0{\cdot}04$. The difference between the two determinations of the more refrangible line the author considers is due to Keeler's having used a wrong value for the wave-length of one of the comparison lines. This line, one of the iron spectrum, is in reality a double, and Keeler used as the wave-length the mean of those of the two components. The author, however, does not agree with this on account of the difference in intensity of the two components. If a correction be applied to Keeler's value it becomes 4,959·17. The measurements of velocity in the line of sight for the three nebulæ are as follows :—

G.C. 4390 — 10·5 km. per sec.
G.C. 4373 — 65·8 „ „
N.G.C. 7027 + 4·9 „ „

A slight difference in velocity was noticed between the edge and centre of the nebulæ. E. C. C. B.

1304. *Errors in Wave-Length Determinations.* **H. M. Reese.** (Astrophys. Journ. 15. pp. 142–147, March, 1902.)—It has been found that in measuring spectrograms for the determination of velocity in the line of sight, a systematic difference is found which appears to depend on the orientation of the length of the spectrum, violet to right end or left. Tables of experimental measures are given to show the degree of personal error introduced in this way, which has to be eliminated by duplicate reduction with plate in direct and reversed positions. C. P. B.

## REFERENCES.

1305. *Electrical Detection of Distant Storms.* **J. J. Landerer.** (Comptes Rendus, 134. pp. 279–280, Feb. 3, 1902.)—An account is given of effects observed with an earthed overhead wire, 288 m. in length, with a galvanometer or telephone. W. R. C.

1306. *Conditions for Accurate Astronomical Photography.* **Loewy.** (Comptes Rendus, 134. pp. 381–387, Feb. 17, 1902.)—The paper contains a survey of the practical precautions necessary for the accurate determination of astronomical positions by photography, and also formulæ for reduction by allowing for the chief sources of error. C. P. B.

1307. *Theory of Capillarity.* **G. Bakker.** (Journ. de Physique, 1. pp. 105–115, Feb., 1902.)—A paper on the same lines as that referred to in Abstract No. 1475 (1901).

# LIGHT.

1308. *Zonal Aberration of Lenses.* **S. P. Thompson.** (Archives Néerlandaises, 6. pp. 747–757, 1901.)—Let parallel rays fall on a (thick) lens, and, after passing through it, strike the axis at points $F_1F_2F_3$, &c. Then the points $F_1F_2$, &c., are not coincident with the point $F_0$ corresponding to the limiting position of paraxial rays, this want of coincidence being the "central" aberration, the ordinary spherical aberration of text-books. Again, if the paths of the rays before entering and after emerging from the lens be produced to meet at points $D_1D_2D_3$, &c., these points will lie on a surface, which is the principal surface, the point where it cuts the axis being identical with Gauss' principal point. The focal lengths $D_1F_1$, $D_2F_2$, &c., are not equal, this want of equality being the cause of the "zonal aberration." No simple lens can be free from both zonal and central aberration, the conditions for the two corrections being incompatible. The form of the principal surface will depend on the curvature of the lens faces; there will also be in every lens two such surfaces, one for a parallel beam in either direction. It is obvious that Gauss' assumption, that in every lens each principal surface is always a plane, is very far remote from actual facts. The author describes experiments made by placing a plano-convex lens obliquely in front of an arc light (with or without a condenser), the image thrown on a screen being balloon-shaped. By attaching a zone plate to the flat surface of the lens and moving the screen, the effects due to the various zones could be studied. The results are illustrated. Further, owing to the pencil after passing through the lens being no longer homocentric, extraordinary shadow phenomena appear on placing objects in the path of the beam. The shadow of a straight rod may be a ring, cross, figure 8, or triangle. A. E.

1309. *Lecture Illustration of Spherical Aberration.* **F. F. Martens.** (Deutsch. Phys. Gesell., Verh. 4. 4. pp. 41–42, Feb. 21, 1902.)—The effects may be shown by means of an ordinary projection lantern with a condenser consisting only of two simple lenses. Owing to spherical aberration, the image of the arc light formed by the condenser will not be sharp, the axial rays coming to a focus at a point further from the condenser than the marginal rays. On a screen placed at some metres' distance a large circular patch of light will be thrown, whose central portion is illuminated by axial rays, and outer portion by marginal rays. If a small disc, 8 mm. in diameter, be placed at the focus of the paraxial rays, a dark spot will appear on the screen, and as the disc is gradually moved along the axis towards the condenser the spot developes into a dark ring, which increases in diameter, until it reaches the edge of the patch when the disc is at the focus of the marginal rays. The disc may be attached to an optical bench. With a triple condenser the aberration is generally too small, but may be increased by turning the lens next the light back to front. A. E.

1310. *Fresnel's Interference Bands Produced by a Right-Angled Prism.* **F. F. Martens.** (Deutsch. Phys. Gesell., Verh. 4. 4. pp. 43–44, Feb. 21, 1902.)—The method affords a means of measuring the angle of an approximately right-angled prism. Rays from a slit are allowed to fall nearly normally on the hypothenuse, and after two internal reflections again emerge nearly normally from the hypotenuse. If 90° — $\alpha$ be the angle of the prism, the interval $b$ between two dark bands is given by $b = \lambda/4\alpha n \, . \, (1 + l/L)$; $l$, L being the distances from the prism of the observer and of the slit. The bands may conveniently be observed by holding a small magnifier near the slit, so that $l = L$. The number will increase and brightness diminish as the prism is moved farther away, while $b$ will remain constant. The width of the slit should only be a fraction of $b$, and its length not more than 1 cm. The angle $\alpha$ may also be measured in the following way: A telescope, with illuminated cross-wires in the eyepiece, is pointed directly at the hypotenuse. Two images of the cross-wires are formed by reflection, whose angular distance will be $4\alpha n V$, V denoting the magnifying power of the telescope. This angle may be measured by utilising the circle and telescope of a small spectrometer reading to 1′. The small telescope, placed with the centre of the spectrometer under the eyepiece of the first telescope, is pointed at each of the two images in turn, and the angle $\beta$ between the two positions is read off on the circle. We have then $\alpha = \beta/4nV$. A. E.

1311. *Optical Constants of Biaxial Crystals by the Refractometer.* **A. Cornu.** (Journ. de Physique, 1. pp. 136–147, March, 1902. Paper read before the Société Française de Physique, Dec. 6, 1901.)—This is a continuation of the work referred to in Abstract No. 1868 (1901). The formulæ there referred to are here worked out, and their employment for the determination of the optical constants is illustrated. The additional matter is entirely analytical. J. W. P.

1312. *Index of Refraction of Red-hot Platinum.* **P. Zeeman.** (Archives Néerlandaises, 4. pp. 314–317, 1901.)—The optical constants of platinum up to 200° were determined by the Babinet's compensator, and the observations were taken to decide questions in dispute between Kundt and Kolaček on the one hand and Sissingh and Drude on the other. Kundt found that the index of refraction of platinum increases by about 27 per cent. for a temperature rise of 100°, while Drude found for platinum, silver, and gold only very small variations. The author finds very small effects. For 800° rise the change of the index is not comparable with that found by Kundt for only 90°. Details of the instrument used are given. Its precision was less than that of the apparatus used by Kundt, but the above contradiction was clearly within the reliable range. J. W. P.

1313. *Half-tone Trichromatic Printing Process.* **F. E. Ives.** (Frank. Inst., Journ. 153. pp. 43–49, Jan., 1902.)—The article describes briefly the process of making three plates by a triple camera devised by the author. The three negatives are taken at one exposure on a single plate, and the subsequent operations are single instead of triple. In this way the number of operations is reduced from fifteen to five, and the printing plates harmonise better, as differences in exposure or development are avoided. Re-etching of the plates is consequently reduced to a minimum, and is frequently not required. A specimen colour-plate is appended. G. H. B.

1314. *Colour-photography.* **A. Hesekiel.** (Phys. Zeitschr. 3. pp. 194–195, Feb. 1, 1902. Paper read before the 73rd Naturforscherversammlung at Hamburg, Sept. 24, 1901.)—The author describes the production of transparencies for three-colour photography, and claims to have so simplified the process as to make it practicable for any photographer. Prints are taken on bichromated celluloid and dyed the proper colours. G. H. B.

1315. *Spectrophotometric Experiments on Skin.* **Camichel** and **Mandoul.** (Journ. de Physique, 1. pp. 101–105, Feb., 1902.)—The coefficient of absorption of the skin of the cervical region of the Guinea-fowl varies with $\lambda^4$. This skin is physically identical in its action with a layer of lampblack. It holds back the harmful radiations of greater refrangibility, and allows the less refrangible rays to pass into the organism. A. D.

1316. *The Absorption Spectrum of the Indophenols.* **Camichel** and **Bayrac.** (Journ. de Physique, 1. pp. 148–151, March, 1902. Paper read before the Société Française de Physique, April 12, 1901.)—The usual definition of an absorption band in a spectrum in reference to its extremities is inconvenient owing to variations due to changes in concentration, nature of light employed, and the length of absorbing layer. The definition of a band by a point corresponding to the maximum or minimum of absorption coefficient is free from the above disadvantages. The position of this point may readily be determined on Crova's spectrophotometer. The slit of this instrument is divided into two parts, one being illuminated by a beam of light of intensity $I_1$, which passes through two nicols, and the other by a beam of intensity $I_2$, which passes through the absorbing substances. The two spectra are equalised, when $I_1 \sin^2 a = KI_2$ where $\frac{\pi}{2} - a$ is the angle of the nicols and K a constant. In practice the following method is employed: The eyepiece of the telescope of the instrument is provided with shutters to limit the observed region. The extremity of a band is observed and the two spectra made of equal brightness; the angle $a$ is then read and also the scale-reading of the telescope. The latter is then slowly moved towards the other side of the band until the two spectra again become equal. A second scale reading is thus obtained for the same value of $a$. Several pairs of points of equal brightness in the band are obtained in this way, each pair giving a different value of $a$. The scale readings are then plotted against $\sin^2 a$, there being of course two for each value of $\sin^2 a$. A curve is drawn through the points and a line is drawn through the means of all the pairs of scale readings. This line, usually straight, will cut the curve at the point of maximum absorption. The authors applied this method to the spectrum of the indophenols. Their solutions in alcohol, ether, and carbon bisulphide show a coefficient of absorption proportional to the concentration, and the position of the maximum of absorption in the yellow does not change with concentration. The following results were obtained: (*a*) Kundt's law regarding the influence of the solvent was not found to be applicable. (*b*) The ortho substitution in the original phenol caused a considerable shift of the absorption maximum towards the more refrangible rays in any solvent. (*c*) The meta substitution caused a slight shift sometimes to one side and sometimes to the other. The replacing of a tertiary nitrogen atom by a primary nitrogen atom causes a shift of the band to the more refrangible end of the spectrum in any solvent. E. C. C. B.

1317. *The Effect of Sodium on the Hydrocarbon Bands in the Spectrum of the Bunsen Flame.* **P. Lewis.** (Astrophys. Journ. 15 pp. 122–124, March, 1902.)—A photometric test of the statement made by Scheiner that the introduction of sodium vapour into a Bunsen burner flame which is showing the hydrocarbon bands makes no difference in the brightness of the latter. Measurements made with a Glan spectrophotometer showed that, if the sodium vapour be actually introduced into the green cone of the flame, the bands are very distinctly diminished. This is important in connection with the theory of the electric origin of the luminosity of comets. E. C. C. B.

1318. *Radiant Induction.* **T. Tommasina.** (Archives des Sciences, 13. pp. 261–273, March, 1902. Paper read before the Physical and Natural History Society of Geneva, Jan. 9, 1902.)—This is a further contribution to the question of the reflection and nature of the radiations of radio-active bodies referred to in Abstract No. 1062 (1902). The discharging action of the radio-active substance is shown not only for air as the medium, but for paraffin and alcohol; and the phenomena, in the author's opinion, cannot be adequately explained by ionisation nor by emission of electrified particles. All the effects of the various radiations are to be traced to a radiation from the anode, and this radiation is of the undulatory type. Thus the flux from the anode arouses the kathode rays; these, on striking a metallic plate, or the glass walls of the tube, give rise to Röntgen rays; these again further secondary rays, and so on. All these radiations are alike complex. They contain parts deviable by the magnetic field, parts non-deviable, rays of various penetrating powers, and so on. Since the nature of the rays depends only on the wave-length, the variety is unlimited. Experiments are described on the same lines as those referred to in the above Abstract, showing that there are in the Becquerel radiation non-luminous rays which have the power of discharging electrified bodies and which undergo reflection. J. W. P.

1319. *Radio-activity.* **F. Henning.** (Ann. d. Physik, 7. 3. pp. 562–575, March, 1902. Communicated by the Physikalischen Institut in Halle. (Abstract).)—Induced radio-activity was imparted to various wires and metal plates, the method of procedure being the same as that adopted by Rutherford [see Abstract No. 2109 (1901)], in which the object acted upon was made the kathode, and placed together with oxide of thorium in a closed brass tube, the tube itself forming the anode. The activity produced in the material exposed to the action of the thorium for about a day was measured by its capacity of producing conductivity in air. One of the objects of the experiments was to find the connection between the intensity of activation and the area of surface of the metal wires and plates. It was found that after the potential difference was raised to a certain value the increase of activity thereby produced was very small, though at first the activity rose rapidly in intensity as the potential difference was increased. With high tensions also no uniform law connecting the intensity of activation and the area of surface can be discerned; the activity appears to be quite independent of the surface. With small potential differences, however, the intensity of activation clearly increases with the surface. A condition of equilibrium appears to establish itself in which the particles or corpuscles to which the emanation is due disappear as rapidly as new ones are produced. The particles may disappear through deposit on the object or on the walls of the tube, and sometimes also direct into the air. The behaviour of metal plates which were rendered active was quite similar to that of wires. In the course of the experiments the potential was raised to 300 volts. An account is also given of experiments on the capability of producing conductivity which is shown by radio-active barium chloride. J. J. S.

# HEAT.

**1320.** *Simple Method of Determining the Temperature of Luminous Flames.* **F. Kurlbaum.** (Phys. Zeitschr. 3. pp. 187–188, Feb. 1, 1902.)—The optical pyrometer devised by Holborn and the author [see Abstract No. 2122 (1901)] is employed. An image of the given flame is formed at the place where the filament of a 4-volt glow-lamp is fixed, and the latter is heated by a current until, attaining the temperature of the flame, it ceases to be visible when viewed through red glass, the temperature being deduced from preliminary observations with a black body, brought to various known temperatures, in place of the flame. This method gives lower estimates of temperatures than Lummer and Pringsheim's (*e.g.*, 1,431° ± 9° C. for a candle instead of 1,582° ± 105°), and doubtless more accurate ones; but it can only be employed when the luminous carbon particles in the flame are not surrounded by gases that exert an uncontrollable absorption within the spectrum-range used. R. E. B.

**1321.** *Dilatation of Steel at High Temperatures.* **G. Charpy** and **L. Grenet.** (Comptes Rendus, 134. pp. 540–542, March 3, 1902.)—The authors have determined by the dilatometric method of Le Chatelier and Coupeau the coefficients of expansion of a number of annealed carbon and nickel steels at temperatures at which there is no transformation of the steel. The results are given in the following tables—they seem to show that iron and carbide of iron have appreciably the same coefficient of expansion :—

TABLE I.

| Composition of Steels. | | | | | Mean Coefficients of Expansion from | | | | |
|---|---|---|---|---|---|---|---|---|---|
| C | Mn | Si | P | S | 1·5° to 200° | 200° to 500° | 500° to 650° | | |
| 0·03 | 0·01 | 0·03 | 0·013 | 0·023 | $11{\cdot}8\times10^{-6}$ | $14{\cdot}3\times10^{-6}$ | $17{\cdot}0\times10^{-6}$ | $24{\cdot}5\times10^{-6}$ | Between 880° and 950° |
| 0·25 | 0·04 | 0·05 | 0·010 | 0·010 | 11·5 | 14·5 | 17·5 | 23·3 | „ 800° and 950° |
| 0·64 | 0·12 | 0·14 | 0·009 | 0·010 | 12·1 | 14·1 | 16·5 | 23·3 | „ 720° and 950° |
| 0·93 | 0·10 | 0·05 | 0·005 | 0·010 | 11·6 | 14·9 | 16·0 | 27·5 | „ „ „ |
| 1·23 | 0·10 | 0·08 | 0·005 | 0·009 | 11·9 | 14·3 | 16·5 | 33·8 | „ „ „ |
| 1·50 | 0·04 | 0·09 | 0·010 | 0·010 | 11·5 | 14·9 | 16·5 | 36·7 | „ „ „ |
| 3·50 | 0·03 | 0·07 | 0·005 | 0·010 | 11·2 | 14·2 | 18·0 | 33·3 | „ „ „ |

TABLE II.

| Analysis. | | | Mean Coefficients of Expansion from | | | | |
|---|---|---|---|---|---|---|---|
| Ni | C | Mn. | 15° to 100° | 100° to 200° | 200° to 400° | 400° to 600° | 600° to 900° |
| 26·9 | 0·35 | 0·30 | $11{\cdot}0\times10^{-6}$ | $18{\cdot}0\times10^{-6}$ | $18{\cdot}7\times10^{-6}$ | $22{\cdot}0\times10^{-6}$ | $23{\cdot}0\times10^{-6}$ |
| 28·9 | 0·35 | 0·36 | 10·0 | 21·5 | 19·0 | 20·0 | 22·7 |
| 30·1 | 0·35 | 0·34 | 9·5 | 14·0 | 19·5 | 19·0 | 21·3 |
| 34·7 | 0·36 | 0·36 | 2·0 | 2·5 | 11·75 | 19·5 | 20·7 |
| 36·1 | 0·39 | 0·39 | 1·5 | 1·5 | 11·75 | 17·0 | 20·3 |
| 32·8 | 0·29 | 0·66 | 8·0 | 14·0 | 18·0 | 21·5 | 22·3 |
| 35·8 | 0·31 | 0·69 | 2·5 | 2·5 | 12·5 | 18·75 | 19·3 |
| 37·4 | 0·30 | 0·69 | 2·5 | 1·5 | 8·5 | 19·75 | 18·3 |
| 25·4 | 1·01 | 0·79 | 12·5 | 18·5 | 19·75 | 21·0 | 35·0 |
| 29·4 | 0·99 | 0·89 | 11·0 | 12·5 | 19·0 | 20·5 | 31·7 |
| 34·5 | 0·97 | 0·84 | 3·0 | 3·5 | 13·0 | 18·75 | 26·7 |

D. H. J.

**1322.** *Heat-conductivity of Copper.* **W. Schaufelberger.** (Ann. d. Physik, 7. 3. pp. 589–630, March, 1902.)—The stationary- and variable-temperature methods of determining conductivity seem to give discordant results : the author finds that this is in part due to the assumption generally made that the end of a heated bar acquires the temperature of the water with which it is surrounded—which may lead to a 10 per cent. error. A uniform bar of very pure copper, 9·5 cm. long and 7·03 mm. in diameter, with copper discs, 4 mm. thick and 5 cm. in diameter, driven on to its ends, was placed axially into a glass tube, the discs serving to close the tube and to lead a 20-ampere current through the rod. Iron-constantan thermoelements were inserted into holes bored at the middle of the rod and 7·5 mm. from its ends. The whole was immersed in water at 18°, a constant stream of which was continuously driven against the two discs. From readings taken when the temperatures were stationary the conductivity was found to be 0·9480, and from renewed readings with falling temperatures after the current had been cut off, the value found was 0·9382. These numbers differ by only ½ per cent. from their mean. A complete mathematical theory of the experiments is given, together with an investigation of the effect of the falling temperatures on the motion of the galvanometer needle. R. E. B.

**1323.** *Equilibrium of a Heavy Gas.* **F. M. Exner.** (Ann. d. Physik, 7. 3. pp. 683–686, March, 1902.)—The author considers the equilibrium of an ideal gas in a long, vertical, non-conducting tube of unit section, assuming, however, gravity to be uniform. If the characteristic is $p = \mathrm{RT}\rho$, where $\rho$ denotes density, the whole entropy is $\int_0^\infty (\mathrm{B} + c \log \mathrm{T} - \mathrm{AR} \log \rho)\rho dh$, where A is the heat-equivalent of work, B a constant, and $c$ the isometric specific heat, $h$ denoting height: and this entropy must be a maximum, while the whole mass $\int_0^\infty \rho dh$, and the whole energy $\int_0^\infty (\mathrm{D} + c\mathrm{T} + \mathrm{A}gh)\rho dh$ [which the author gives wrongly as $\int_0^\infty (\mathrm{CT} + gh)\rho dh$, where C is the isopiestic specific heat] are constant, and $dp = -g\rho dh$. Application of the Calculus of Variations then gives—

$$(d/dh) \log \mathrm{T} + g/\mathrm{RT} = -(d/dh) \log \rho = \text{constant} = \nu\,;$$

whence $\nu\mathrm{RT}/g - 1 = (\nu\mathrm{RT}_0/g - 1)\, e^{\nu h}$ and $\rho = \rho_0 e^{-\nu h}$, so that $p_0 \equiv \mathrm{M}g = \rho_0 g/\nu$, and thus $\nu = g/\mathrm{RT}_0$ and $\mathrm{T} = g/\nu\mathrm{R} = \mathrm{T}_0$, the subscripts referring to $h = 0$. Hence the temperature is the same throughout the column when it is in equilibrium. R. E. B.

**1324.** *Heat Conductivity of a Gas in Motion.* **L. Natanson.** (Acad. Sci. Cracovie, Bull. 3. pp. 137–146, March, 1902.)—According to his usual method the author takes $u + \xi$, $v + \eta$, $w + \zeta$ for component velocities of the "material points," or "molecules," of which the gas is assumed to consist. Here $u\ v\ w$ are introduced as the components of "*vitesse hydrodynamique*" of the "element of volume" in which the molecule whose component velocities are $u + \xi$, &c., is at the instant considered. It is necessary to assume here that an infinitely small space contains an infinite, or great, number of these molecules, and that consequently a molecule cannot have finite dimensions or occupy exclusively a finite part of space. For if it did, the "element of volume" must be finite, and $u\ v\ w$ would generally depend on the size of the element chosen, and so would be indeterminate. $\xi\ \eta\ \zeta$ are the velocities of the molecules in the element relative to their common centre of inertia, so that $\bar{\xi} = \bar{\eta} = \bar{\zeta} = 0$.

Q denotes any function of the velocities, $\bar{\mathrm{Q}}$ its mean value. And $d/dt$ as applied to any such function stands for $\partial/\partial t + u\partial/\partial x + v\partial/\partial y + w\partial/\partial z$. The fundamental equation of the theory is then—

$$\rho\frac{d\overline{Q}}{dt} + \frac{\partial}{\partial x}\left(\overline{\rho\xi Q}\right) + \frac{\partial}{\partial y}\left(\overline{\rho\eta Q}\right) + \frac{\partial}{\partial z}\left(\overline{\rho\zeta Q}\right)$$
$$= \rho\frac{\delta Q}{\delta t} + \rho\left(X\frac{\partial\overline{Q}}{\partial u} + Y\frac{\partial\overline{Q}}{\partial v} + Z\frac{\partial\overline{Q}}{\partial w}\right),$$

in which $\rho$ denotes density—but without a definition in the present paper—$\frac{\delta}{\delta t}$ denotes variation due to intermolecular action, and X Y Z are components of external force. The method followed consists in giving to Q different values as functions of the velocities. In the present paper they are successively—

$$Q = u + \xi,\ Q = (u + \xi)^2,\ Q = (u + \xi)(v + \eta),\ \&c.$$
$$Q = (u + \xi)\left\{(u + \xi)^2 + (v + \eta)^2 + (w + \zeta)^2\right\}.$$

In working out these formulæ, the function $\Psi$ is employed, namely—

$$\Psi = \rho\overline{\xi^2}\frac{\partial u}{\partial x} + \rho\overline{\eta^2}\frac{\partial v}{\partial y} + \rho\overline{\zeta^2}\frac{\partial w}{\partial z}$$
$$+ \rho\overline{\xi\eta}\left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\right) + \&c.,$$

or for small disturbances—

$$\Psi = \frac{\rho}{3}\left(\overline{\xi^2} + \overline{\eta^2} + \overline{\zeta^2}\right)\left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z}\right),$$

and this again assumes the form $-\frac{2}{3}c\theta\frac{d\rho}{dt}$, where $c$ is the specific heat at constant volume. Hence, approximately,

$$c\rho\frac{d\theta}{dt} + \Psi = c\rho\theta\frac{d}{dt}\log\frac{\theta}{\rho^{\frac{2}{3}}}$$

This is compared with the known law of Laplace and Poisson for the "*détente*" of a gas. The author obtains in a more general form the relations between "flux" and "stimulant" given in his former memoir. He considers also the case in which the gas in which heat is propagated has uniform motion of dilatation or contraction denoted by—

$$\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y} = \frac{\partial w}{\partial z} = \frac{1}{3}\theta$$

If, he says, an observer could distinguish the effect of pure conduction from this motion, the coefficient, K, of conduction of heat would become $K' = K\left(1 - \frac{7}{8}\theta T\right)$. Here T is defined by the equation—

$$\frac{\delta}{\delta t}\overline{\xi(\xi^2 + \eta^2 + \zeta^2)} = -\frac{\overline{\xi(\xi^2 + \eta^2 + \zeta^2)}}{T}$$

S. H. B.

1325. *The Boiling-point of Selenium and other Pyrometric Constants.* **D. Berthelot.** (Comptes Rendus, 134. pp. 705–708, March 24, 1902.)—By the interference method previously applied to the determination of the boiling-points of cadmium and zinc [see Abstract No. 2183 (1900)] the author has now determined that of selenium to be 690° + (H − 760)/10, H being the barometric pressure in millimetres of mercury. Equality of temperature between the gaseous column and the selenium bath was tested by means of a platinum-iridium thermo-couple. The author considers the estimation as probably accurate to ± 2°.

W. E. T.

1326. *Specific Heat of Bodies at Absolute Zero.* **Ponsot.** (Comptes Rendus, 134. pp. 703–705, March 24, 1902.)—Discussing a gaseous homogeneous mixture of bodies in chemical equilibrium, the author deduces the general law that at absolute zero two systems of solid bodies comprising the same elements have the same specific heat, and as a particular case that the specific heat of a compound in the solid state is equal to the sum of the specific heats of its separate elements in the solid state. It further is shown that the specific heat of a solid body and that of its saturated vapour both tend towards the value zero for absolute zero of temperature. W. E. T.

1327. *Thermic Equivalent of Dissociation and of Vaporisation and Heat of Solidification of Ammonia.* **de Forcrand.** (Comptes Rendus, 134. pp. 708–711, March 24, 1902.)—From the general relation [see Abstract No. 2419 (1901)], $(L + S)/T = Q/T' = (L + S + q)/T' = q/\theta = K = 30$, it follows that, when $q$ becomes equal to 1 Cal., the mean value of $\theta$ is 33°·33. This number, the thermic equivalent of dissociation, expresses that, if a dissociable compound has a tension of 760 mm. at a temperature $n$ degrees above the temperature of ebullition of the gaseous molecule, the total heat of combination exceeds by $n/33{\cdot}33$ the heat of solidification of this molecule. It also follows that the same number is the thermic equivalent of vaporisation and that a dissociable body having a tension of 760 mm. at $n$ degrees absolute temperature will have a total heat of formation of $n/33{\cdot}33$. A study of the ammoniacal metallic chlorides leads to the mean value 31°·10 for their thermic equivalent of dissociation, in close agreement with the value 31·2, deduced from the mean value 32, of the ratio $Q/T$ for this series. It follows that the heat of solidification of $NH_3$ gas will be + 7·695 Cal.; and in general the heat of solidification of a gaseous molecule can be determined when the dissociation and heat of formation of a certain number of its dissociable combinations are known, or the temperature may be determined at which a compound, for which Q is known, will have a tension of 760 mm. W. E. T.

1328. *Latent Heat of Fusion of Solid Ammonia.* **G. Massol.** (Comptes Rendus, 134. pp. 653–655, March 17, 1902.)—By dissolving in water (at 10°) liquid ammonia at −75°, and solid ammonia at a temperature as near as possible to −75°, the author has experimentally determined their heats of solution as respectively + 1·77 Cal. and − 0·068 Cal. Subject to the small error arising from the impossibility of taking the substance in both states at exactly the same temperature, it follows that the molecular latent heat of fusion of solid ammonia is − 1·838, very nearly equal to that of water.

W. E. T.

1329. *Heat of Solution of Cadmium Sulphate.* **H. B. Holsboer.** (Zeitschr. Phys. Chem. 39. pp. 691–710, March 18, 1902. Abstract from an Inaugural Dissertation, Dec., 1900.)—As the number of water molecules present with 1 $CdSO_4$ molecule increased from 14 to 500, the specific heat of the solution, determined by Berthelot's method, was found to increase from 0·610 to 0·972, the increase becoming less rapid as the solution became more dilute. The specific heat of the solid hydrate, $CdSO_4 . 8/3\, H_2O$ was found to be 0·225. The heat of solution at 15° of this hydrate with 404 water molecules, and the heat evolved on diluting solutions of various concentrations were next determined, and thence the heats of solution at 15° of the solid hydrate in various quantities of water were calculated. The heats of solution at 5° and 25° were deduced from this, and the specific heats, as determined above, and the corresponding curves drawn. By Roozeboom's construction (Verslag. Kon. Acad. van Wetensch. 28 Feb., 1885, and Rec. 4, 135, and Rec. 8, 123. 1889), or van Deventer's calculation method (Zeitschr. Phys. Chem. 5, 555, 1890, and 9, 53, 1892), the theoretical heat of solution in the saturated solution was determined. At lower temperatures this was found to be positive, vanishing about 15° and being negative for higher temperatures, thus in harmony with the minimum of solubility of the hydrate found at 15° by Kohnstamm and Cohen. [See Abstract No. 1059 (1898).] W. E. T.

1330. *Effect of Heat on the Texture of Silica Jelly.* **J. M. van Bemmelen.** (Archives Néerlandaises, 6. pp. 607–624, 1901.)—The author had previously shown that the jelly really consisted of a kind of tissue, which had been shown under the microscope by Bütschli and Hardy to exist as an open network, or as a mass of polygonal cells 1·4 to 1·5 $\mu$ in diameter, with walls about 0·3 $\mu$ thick. The large quantity of water absorbed and enclosed is not in chemical combination, and can be replaced by other liquids. When slowly dried at ordinary temperatures, the jelly at a certain point, called by the author the "change-point" (umschlagspunkte), loses its transparency through air entering the cells, but becomes clear again when this is displaced by a miscible liquid. The absorbed air is found to be condensed to a pressure of 1 atmosphere. When the jelly is dried over $H_2SO_4$ till its vapour tension is reduced to zero, 0·3 to 0·1 molecule of water to 1 of $SiO_2$ is left. By exposure to aqueous vapour the cell cavities gradually refill with water, while the air is expelled, the volume of the jelly remaining almost unchanged, until finally as much water is absorbed as was present at the point of change. The phenomena can be repeated indefinitely. Isothermal curves can be constructed, and the position of the change-point depends on the structure of the jelly and the constitution of the cell-walls, which differ according to the concentration of the forming solution and the speed and temperature of the drying. The power of absorption of water, alcohol and other vapours is very strongly reduced by heat, and at low redness may be entirely removed; in this case some air-bubbles appear on immersion in water. The present research shows that the density of the cell-walls near the change-point is 2·5 to 3, and that by heating to redness it becomes 2·2, while the cell cavities almost entirely disappear, and the walls become generally impervious. S. R.

1331. *Heat Convection in Liquids.* **J. Boussinesq.** (Journ. de Physique, 1. pp. 65–71, Feb., 1902.)—Suppose a solid body, kept at constant temperature $a$, to be immersed in an unlimited mass of liquid, of density $\rho$, initially at temperature 0, the expansibility of which is so small, while gravity is so large, that relative changes of the *volumes* of its parts are negligible though the reduction $\gamma\rho$ of the *weight* of unit volume produced by a rise of 1° is sensible. If $u, v, w$ are the velocity-components and P the non-hydrostatic part of the pressure at the point $(x, y, z)$ where the temperature $\theta$ has become stationary, and if $b=(a\gamma K/C)^{\frac{1}{3}}$, $c=(a\gamma C^2/K^2)^{\frac{1}{3}}$, where K, C are the conductivity and the specific heat, then the equations of motion show that $\theta/a$, $u/b$, $v/b$, $w/b$, $P/\rho b$ are definite functions of $cx$, $cy$, $cz$, as is therefore also $F/Kac$, where F is the flow of heat; whence similar systems, with the surfaces of their solids given by $f(cx, cy, cz)=0$, are readily comparable. Now $Kac=(a^4\gamma KC^2)^{\frac{1}{3}}$, so that for similar systems in the same liquid the flow at the surface varies as $a^{\frac{4}{3}}$; but for the *same* body in gases Dulong and Petit found the flow to vary as $a^{1\cdot233}$, so that the dimensional effect seems to be of the form $a^{-0\cdot1}$ or rather $c^{-0\cdot3}$; hence the cooling power of different liquids *on the same body* may be taken as proportional to $Kac.c^{-0.3} = Kac^{0.7}$. Another result is that for a thin vertical plate the upward acceleration of the liquid is everywhere approximately proportional to its actual temperature. R. E. B.

1332. *Cooling Power of a Stream.* **J. Boussinesq.** (Journ. de Physique, 1. pp. 71–75, Feb., 1902.)—Suppose a current of fluid to be flowing with constant velocity $\nu$ past a body kept at constant temperature $a$. For this case the equations of the preceding Abstract require modification, and if $\gamma\rho\theta$ is neligible they show that $u/\nu$, $v/\nu$, $w/\nu$, $P/\rho\nu^2$ are functions of $jx$, $jy$, $jz$, where $j$ is a parameter, and that $\theta/a$ is a function of these terms and of $jK/C\nu$, as also therefore is $F/jaK$, which gives Newton's law (see Abstract No. 853 (1902). If the body were an indefinitely large thin plate parallel to the current and bounded by an edge perpendicular to the current, the flux of heat is proportional to $a\sqrt{(KC\nu)}$, where $a$ is the mean temperature-excess of the plate over the fluid. R. E. B.

1333. *Mathematical Treatment of the Second Law of Thermodynamics.* **A. Denizot.** (Ann. d. Physik, 7. 2. pp. 358–368, Feb., 1902.)—A purely mathematical deduction of the Second Law is here attempted. The integrating factor $g$ of the expression $du + pdv$ for the heat expended along a reversible path is obtained by the solution of the equations—

$$-dt/(p + \partial u/\partial v) = dv/(\partial u/\partial t) = d \log g/(\partial p/\partial t)\,;$$

the efficiency also of an infinitely small Carnot's cycle, which the author *assumes* to be of the form $dL$, is $dt(\partial p/\partial t)/(p + \partial u/\partial v)$; whence he [unjustifiably] concludes that $d \log g = -dL$, and $(\partial u/\partial t)dt = 0$, so that $\partial g/\partial v = 0$, and the desired result follows. R. E. B.

1334. *Irreversible Processes and Planck's Theory.* **S. H. Burbury.** (Phil. Mag. 3. pp. 225–240, Feb., 1902.)—If a material system is divided into parts, $a_1, a_2 \ldots a_n$, and it is assumed that they possess, respectively, energies varying with the time and subject to the condition that their sum is equal to the energy, U, of the system, and further that each emits in time, $dt$, energy proportional to the corresponding $u$, it is shown that a function exists necessarily diminishing with the time which may be called the entropy of the system. An account is then given of Planck's theory, and it is shown that the conditions for the transfer of energy between the resonator and wave considered by him are the conditions necessary for the application of the above theorem, and that therefore an entropy function may be expected to exist. The author points out that Planck's proof, that the entropy of the resonator and wave continually increases until a stationary state is reached, appears incomplete, and shows how to supplement it by averaging for all waves and resonators of the same period. He also objects to the term written down by Planck for the change of entropy of the system, and notes that the interchange of energy between systems of different periods, which will take place in accordance with Planck's equation, though at a slower rate than for systems of the same period, requires further investigation. In conclusion, it appears doubtful whether Planck's process is really an irreversible process, as the existence of such a thing as his resonator cannot be proved by experiment, for any actual electric vibration such as he proposes must be accompanied by dissipation of energy. [See also Abstracts Nos. 1660 and 1953 (1901).] W. E. T.

**1335.** *Man as a Heat-engine.* **N. Zuntz.** (Phys. Zeitschr. 3. pp. 184–185, Feb. 1, 1902.)—Criticism of K. Schreber's paper [see Abstract No. 695 (1902)]. The external temperature cannot be a criterion : a man can do work in air hotter than his body ; a fish can swim in water sensibly of the same temperature as its body. Each muscle fibre is an independent machine. When work is done extra food is consumed ; and 39 to 40 per cent. of the energy of this food is transformed into work, say 31 to 34 into external work and 6 to 7 into extra circulation and respiration work. When the body is at rest the whole of the energy of the food consumed is ultimately converted into heat and there is no appreciable storage of energy ; the energy of the food is primarily expended in keeping up the circulation and respiration, the digestive movements, the movements of contractile cells, the chemical and osmotic activity of glands, and the uniform temperature. In a muscle, an efficiency of 40 per cent. would, with a surrounding temperature of 37°, correspond to an internal temperature of 244° ; the chemical change $C+O_2=CO_2$ would correspond to one of 10,000. The muscle cannot, therefore, act as a heat-engine. Theories of Engelmann (Ueber d. Ursprung d. Muskelkraft, Leipzig, Engelmann, 1893), Pflüger (Pflüger's Arch. 10, 329, 344, 641), Fick (Pflüger's Arch. 53, 106, and 54, 313), and Bernstein (the same, 85, 271) as to the mechanism of muscle-contraction are referred to. A. D.

## REFERENCE.

**1336.** *Empirical Isotherms of Binary Mixtures.* **P. A. Kohnstamm.** (Konink. Akad. Wetensch. Amsterdam, Versl. 9. pp. 432–437, 1902.)—After discussing the various methods used to determine vapour pressures of binary mixtures and accounting for their defects, the author deduces their empirical isotherms in order to show that the phenomena observed are in strict accordance with current views on binary mixtures. A. G.

## SOUND.

1337. *Sound Signals.* **E. Price-Edwards.** (Soc. Arts, Journ. 50. pp. 315–327; Discussion, pp. 327–330, March 7, 1902.)—After referring to the trials made in 1874 under the auspices of the Trinity House Corporation, the author describes the matters requiring test and the instruments available in 1901. The relative efficiency of high and low notes; the relative advantages of one large trumpet or several smaller ones to guard a given arc; the relative merits of the developed forms of sirens and horns; new forms of trumpet; the effect of atmospheric condition—all these are investigated. The testing was done on the steam yacht *Irene*, and the region was from St. Catharine's Point, Isle of Wight. In the trials between different types of siren the disc siren proved superior to the cylinder siren, especially in calm weather. As between reed-horn and siren, the latter proved much superior; and in tests of different types of reed-horn the Stentor instrument proved the best. An elliptical form of trumpet, invented by Rayleigh, gave in conjunction with the siren better results than the ordinary circular form. Mushroom-head trumpets were also found an improvement where it is desired to send the sound out in all directions. The effects of wind, fog, and pitch of the notes are described, and the phenomena of the silent area and sea echoes are referred to.
J. W. P.

1338. *Origin of Tones in an Organ-pipe.* **W. Friedrich.** (Ann. d. Physik, 7. 1. pp. 97–115, Dec., 1901. Rostocker Dissertation.)—There are three distinct investigations in this paper: (1) The condition of the blast of air entering the pipe; (2) the condition of the lips of the pipe; (3) the secondary air-streams in the body of the pipe. The results found are: (*a*) The blast entering the pipe vibrates in unison with the air in the pipe—this was found by a König flame manometer; (*b*) but if the body of the organ-pipe be removed no vibrations occur; (*c*) an air-current sets up one side of the pipe and down the opposite side; (*d*) eddies occur in the centre of the pipe; these can be stopped by introducing a partition along the length of the pipe. A sensitive method of studying the vibrations was to have a circuit including a mercury-contact and two electromagnet coils. Any movement in a fine membrane carrying an iron plate near an electromagnet produces induced currents in the circuit, which make and break the circuit at the mercury cup.
P. E. S.

## REFERENCE.

1339. *Experimental Phonetics.* **J. G. M'Kendrick.** (Nature, 65. pp. 182–189, Dec. 26, 1901. Paper read before the British Association.)—This is an interesting *résumé* of experimental research into the nature of spoken sounds, and a very complete guide to the bibliography of the subject.
G. W. DE T.

# ELECTRICITY AND MAGNETISM.

## THEORY AND ELECTROSTATICS.

**1340.** *Magnetic Shells Equivalent to Circular Coils.* **T. R. Lyle.** (Phil. Mag. 3. pp. 310–329, March, 1902.)—We are to suppose a coil of $n$ turns with current C wound on a cylinder of radius $a$, where $\xi$ is the breadth of the wire measured parallel to the axis of the coil, $\eta$ its thickness, $x$ the distance of a point in the axis from the centre of the coil, and $\rho^2 = a^2 + x^2$. With this notation the writer obtains, using Maxwell's formula for the magnetic potential of the coil at any point in its axis—

$$V = 2\pi n C\left(1 - \frac{x}{\rho} + \frac{\eta^2 x}{24\rho^3} + \frac{\xi^2 - \eta^2}{24\rho^5}\, a^2 x\right)$$

to a sufficient approximation.

The potential of a circular magnetic shell of radius $r$ concentric and coaxial with the coil is—

$$V' = 2\pi n C\,.\left\{1 - \frac{x}{\sqrt{x^2 + r^2}}\right\}$$

Now V and V′ are identical if—

$$\frac{1}{r} = \frac{1}{a}\left(1 - \frac{3\xi^2 - 2\eta^2}{24a^2}\right),\ \frac{1}{r^3} = \frac{1}{a^3}\left(1 - \frac{3(5\xi^2 - 4\eta^2)}{24a^2}\right),\ \frac{1}{r^5} = \frac{1}{a^5}\left(1 - \frac{5(7\xi^2 - 6\eta^2)}{24a^2}\right), \&c.,$$

and if identical on the axis, they are so at all points external to the coil.

The radius $r$ so determined is called by the writer *the equivalent radius* of the coil. By making $\xi = \eta$ we satisfy the above condition, and we make the cross-section square. Such a coil the writer calls a single-shell coil.

He then proceeds to more general cases of equivalence, especially the case in which $\xi \tau \eta$, and the coil is replaced by an equivalent system of two filaments, placed at distances from the centre $\pm \frac{\xi^2 - \eta^2}{12}$. This is called a double-shell coil. He gives practical methods for measuring the equivalent radii. The determination of the mutual inductance of two coaxial circular coils is reduced to that of finding the mutual potential of the equivalent filaments. The paper concludes with notes on the application of the method to a current balance of the type used by Rayleigh and Mrs. Sidgwick.

S. H. B.

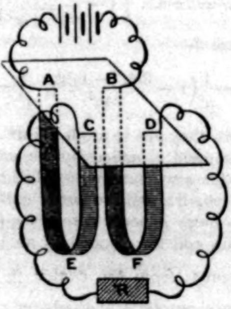
**1341.** *Boundary Conditions of the Electric Field.* **W. Duane.** (Phys. Rev. 14. pp. 149–157, March, 1902.)—The author's object is to show that the electric charge $e$ being given at each point in space, the potential V is not uniquely determined without some boundary conditions. For if there be two values $V_1$ and $V_2$, and $V_1 - V_2 = \phi$, we have by Green's theorem applied to infinite space—

$$\int \left\{ \left(\frac{d\phi}{dx}\right)^2 + \&c. \right\} d\tau = \int \phi \frac{d\phi}{d\nu}\, dS - \int \phi \nabla^2 \phi\, d\tau = \int \phi \frac{d\phi}{d\nu} dS$$

because the second volume integral is zero. There is nothing, he says, in

Heaviside's fundamental equations to show that the surface integral vanishes, which is necessary in order that we may deduce $d\phi/dx = 0$, &c., and therefore $V_1 = V_2$. In fact, as he says, in the equation $e = \frac{-1}{4\pi}\nabla^2 V$, you may add to V any function $f$ of $x, y, z$, which satisfies $\nabla^2 f = 0$, *e.g.*, $f = Ax + B$, where A and B are constants. Assuming the total electric energy to be finite, he finds that, if P be the electric force at the bounding surface of a sphere of radius $r$, $Pr$ must be zero when $r$ becomes infinite. This is the boundary condition. Similar reasoning is applied to the general case of an electromagnetic field. S. H. B.

**1342.** *The Electrostatic Field surrounding an Electric Current.* **W. de Nicolaiève.** (Comptes Rendus, 134. pp. 33–36, Jan. 6, 1902.)—The author describes experiments made with the apparatus shown in the illustration. The two bands, AEC, BFD, are 8 mm. wide and 30 mm. long, and distant 4 to 5 mm. The battery being put in action, the circuit may be open, C and D, the extremities of the two bands, being insulated, or may be closed by a rheostat of resistance 900 ohms, giving for a battery of 100 volts a current 0·11 of an ampere. With an unclosed current the two bands acquire electric charges of opposite signs and so attract each other. When the circuit is closed by the rheostat the two bands carry currents in opposite directions, and so tend to repel each other electrodynamically; but it is found (experiment 2) that with the feeble current of 0·11 ampere the result is nearly the same as with the unclosed circuit. The explanation given is that the electrostatic tubes of force continue to exist, but slide along the conductor, diminishing the difference of potential between their extremities. When the resistance of the rheostat is diminished to 200 ohms, and the current proportionally increased, it is found that the repulsive force, varying as the inverse distance, prevails over the attractive force which varies as the inverse square. The apparatus is enclosed in a vertical glass tube, and the results of several experiments are given in which the tube is filled with naphtha or water. Also (experiment 7) for Hertz's two linear conductors are substituted two flexible bands at distances 15–20 cm. It is found that they attract each other powerfully. The author's explanation is that we have here tubes of force sliding by these extremities along the conductors, and this, he says, is the reason why the velocity of propagation is the same in the medium as in the conductors. He holds that the experiments confirm Poynting's theory. S. H. B.



1343. *Rotations Produced by Electric Sparks.* **A. G. Dell.** (Elect. World and Engineer, 39. pp. 300–301, Feb. 15, 1902.)—This paper describes further experiments made by the author of a kind similar to those already described in Abstract No. 1310 (1901), in which it was shown that a lacquered mica disk, suspended on a vertical axle, could be made to rotate by the passage of electric sparks close to it and under it. The effect on the rotations of moisture on the disks and on the supports of the electrodes is now considered, and the author is of opinion that in wireless telegraphy, if the spark-gap and the metal capacities near the gap were as far as possible placed in a box containing dry air, the arrangement would work with greater constancy. W. C. H.

1344. *Atmospheric Electricity in Southern Algiers and near Tunis.* **A. Gockel.** (Phys. Zeitschr. 3. pp. 208–210, Feb. 15, 1902.)—A preliminary account is given of observations taken in August and September, 1901, at Biscra, in the Oasis of Tougourt, and at Hammam el Lif on the seashore near Tunis. The dispersion coefficients were, on the whole, higher in the desert than in Freiburg, Switzerland, 10 per cent. against 5, and the potentials lower, 35 V/*m* against 100 V. The depression went down to 1 per cent. while the potential rose to 150 V, half an hour before sunset in the desert (at Freiburg, after sunset, there was no characteristic change on the seashore); this may be connected with the dust and haze which seem to impede the negative ions more than the positive, and with vertical air-currents. A rise in the potential at sunrise was not noticed. Apart from this sudden jump in the evening and the forenoon (9 a.m.) maximum, the potential variations were little marked. On the Mediterranean the potential rose from 30 V/*m* in the early morning to about 80 V; the average dispersion was 65 per cent. H. B.

## DISCHARGE AND OSCILLATIONS.

1345. *Electric Charging and Discharging at a Distance.* **H. Ayrton.** (Nature, 65. p. 390, Feb. 27, 1902.)—An electroscope can be discharged at short distances (15 cm.) by a candle-flame; at long distances (up to 200 cm.) by an insulated candle-flame towards which an opposite charge is brought and then withdrawn. It can be similarly charged with an insulated candle and a charged rod up to 200 cm. distance. A red-hot platinum wire acts much like a candle up to 300 cm. distance; apparently this power depends on the presence of some sodium. Insulated cotton-wool dipped in ether, methylated spirit, or dilute sulphuric acid acts as well as the candle-flame and in the same way. Dry carbon dust is ineffectual. A. D.

1346. *Dispersion of Electricity by Evaporation of Liquids.* **H. Beggerow.** (Ann. d. Physik, 7. 3. pp. 494–515, March, 1902. Abstract from the Freiburg Dissertation.)—Blake (Wied. Ann. 19. p. 518, 1883) endeavoured to observe directly any possible electric charge possessed by vapour from electrified liquids, but his results were negative. Schwalbe (Wied. Ann. 58. p. 50, 1896) in a different manner also got negative results. Pellat [see Abstract No. 562 (1899)] with a small insulated brass bowl (beneath a glass bell-jar and joined to a quadrant electrometer of small capacity), charged to 116 volts, found a slightly smaller falling off in potential in a given time when the bowl was dry than when it contained a layer of water, and pointed out that the duration of the experiments of all preceding observers had been much too short, and the capacity of their electrometers much too great. The author has repeated

Pellat's experiment with apparatus similar to his, but with negative results, and has carried out new experiments, taking great care to maintain uniformity of external conditions, and testing those conditions frequently throughout the experiments. This latter test was made by having a second apparatus exactly similar to the first, and so placed that the two must be influenced in exactly the same way by alteration in external conditions. He used in the extended series of experiments a shallow nickel-plated tray whose capacity was from 2·86 to 4 times that of the electrometer, which was of Hankel type, and disconnected from the tray except at the beginning and end of an experiment. The initial potential of the tray was 108 volts, and the time of an experiment 60 minutes ; two observations were made with the tray dry, and then two with the tray moist ; Pellat's results seemed to be confirmed. This was suspected to be possibly due to the fact that the air was always more humid with the tray moist and the insulation therefore impaired. This was found to be the case, and when the author removed this source of error he again got negative results ; the liquids used in the tray were water, ether, alcohol, and sodium chloride solution. The author used also an improved form of Blake's apparatus. A metal plate is kept at constant potential, and above it is an insulated collecting-plate which can contain a freezing mixture. This insulated plate is joined to an electrometer, and receives a charge conveyed through the air from the other plate. The author used two identical pieces of apparatus of this kind, the two collecting plates being joined to the two electrodes of a sensitive quadrant electrometer. Of the two other plates one was dry, the other moist. No deflection of the electrometer needle was found. The liquids used were water, alcohol, common salt solution and radio-active solutions (1 per cent. solutions of acetate and nitrate of uranium). Mercury vapour gives also a negative result. Both positive and negative charges were used in every case. In all the experiments, both by Pellat's and by Blake's method, observations were made with the air at rest and with it in motion, except in the case of mercury, where the air was still. W. S.

1347. *Electrical Conductivities Produced in Air by Motion of Negative Ions.* **P. J. Kirkby.** (Phil. Mag. 3. pp. 212–225, Feb., 1902.)—The author describes experiments showing the remarkable difference in the behaviour of positive and negative ions when moving under electric force in a rarefied gas. As the intensity of the electric field is increased, the negative electrolytic current grows very rapidly, while the positive remains practically stationary. Shown by curves, the negative curve separates itself out from the positive, rising high above it. The author then discusses the theory of the subject, showing that his results are in accord with Townsend's theory of collisions [see Abstract No. 1668 (1901)], and to this extent afford additional evidence of its truth. W. C. H.

1348. *Velocity of Ions drawn from the Electric Arc, II.* **C. D. Child.** (Phys. Rev. 14. pp. 65–74, Feb., 1902.)—The method previously used gave the average velocity of the ions. Two modifications of Zeleny's method [see Abstract No. 2420 (1900)], in which the ions are carried along with a current of air of known velocity, are described, which give the velocity of the fastest and slowest ions. A third method devised by Rutherford, in which an alternating e.m.f. is used of such frequency that the fastest ions reach the surrounding cylinder before reversal, whilst the slower ions fail to reach it, gives the relative velocity of the fastest ions of each kind. In each of the comparisons of the most rapidly moving ions, and also in the comparison of the average velocities, the positive ions were found to have the greatest velocity, whilst in the comparison of the slowest ions little difference was found between the two kinds of ions. [See also Abstract No. 1308 (1901).]

T. M. L.

**1349.** *Transition Differences of Potential of the Electric Discharge in Air at Atmospheric Pressure.* **M. Toepler.** (Ann. d. Physik, 7. 3. pp. 477–498, March, 1902.)—This is a continuation of the work referred to in Abstract No. 2020 (1900). The author determines the transition potential differences at which the various forms of discharge, glow, brush, brush-arc and flame-arc begin to occur, and gives an empirical formula for given distance between electrodes, and given diameter of the spherical discharging electrode, the other being a large flat plate.

W. S.

**1350.** *Rate of Recombination of Ions in Gases under Different Pressures.* **R. K. McClung.** (Phil. Mag. 3. pp. 283–305, March, 1902.)—Rutherford (Phil. Mag. Nov., 1897) has shown that if, in any gas exposed to Röntgen rays, the rays be stopped when the rate of production of ions becomes equal to the rate of recombination, the rate at which the conducting particles decay is given by the equation $dn/dt = -an^2$, where $n$ is the number of ions per c.c. in the gas at time $t$ after the rays have ceased, and $a$ is a constant for any given gas at ordinary atmospheric pressure. The author has in these experiments endeavoured (1) to determine whether this law of recombination holds for air under pressures above and below an atmosphere; (2) if so, to find the relation which $a$ at any given pressure bears to that at any other pressure; (3) to make an absolute determination of $a$. The results are as follows: (1) The above equation holds good for ionised air, no matter what the pressure may be, at least between the limits of 0·125 of an atmosphere and 3 atmospheres, used in these experiments; (2) $a$ is independent of the pressure of the air for the above range of pressures; (3) the absolute value of this coefficient of recombination for air has been found to be $3384\epsilon$, or, substituting the value of the ionic charge, $2{\cdot}20 \times 10^{-6}$. Hydrogen and carbon dioxide were also examined, and the same law of recombination was found to hold true as for air. The coefficient $a$ for carbon dioxide is practically the same as that for air, while the coefficient for hydrogen is only about 87 per cent. of the value for air.

W. C. H.

**1351.** *Identity of Negative Ions produced in Various Ways.* **J. S. Townsend.** (Nature, 65. pp. 413–414, March 6, 1902.)—The author gives a brief statement of the results of some experiments recently made, which, taken with those of earlier experiments [see Abstracts Nos. 1103 and 1668 (1901)] lead to the following conclusions: The negative ions set free from a zinc plate when ultra-violet light falls on it generate other ions by collisions with molecules of air, carbonic acid, or hydrogen. The negative ions thus generated by collision in the gases have the same properties (over large ranges of pressure and electric force) as the ions generated by the light from the zinc. Thus the four kinds of ions—those given off by the zinc plate, and the negative ions which they produce in air, carbonic acid, and hydrogen—are identical. And finally, the negative ions generated by Röntgen rays in a gas are precisely the same as those set free from a zinc plate by ultra-violet light. The masses of the negative ions from zinc and of those produced by Röntgen rays are the same, and so also are their free paths and charges. Thus it is possible by various methods to detach from the molecules of gases negatively charged particles, which are small compared with the molecules, and are the same from whatever gas they are removed. W. C. H.

1352. *Stratifications of Hydrogen.* **W. Crookes.** (Roy. Soc., Proc. 69. pp. 399–413, March 21, 1902.)—The author describes experiments made (1) to prepare pure hydrogen, and (2) to investigate the stratifications shown by the pure gas under the influence of an induction current. In the early attempts to prepare the pure gas mercury always showed in the spectrum of the stratifications produced in the gas exhausted to the necessary point. With an improved apparatus and using palladium saturated with hydrogen, the gas at a pressure of 4 mm. gave 12 strata of a concavo-convex button-shape, each blue on the convex side facing the negative pole and pink on the other side. Reversal of the current caused the buttons to reverse also, so that they always presented the blue side to the negative pole. Spectroscopic examination showed hydrogen lines in the pink part, and both hydrogen and mercury in the blue. When the pressure was then reduced to 2 mm. the whole of the blue faces suddenly migrated to form one bright blue, well-formed button nearest the negative pole, leaving the other buttons pink in colour. The spectrum of the blue button showed not a trace of even the brightest hydrogen line, only mercury being detected ; on the other buttons the hydrogen lines were in excess, but mercury could be seen all along the tube. Further efforts were made to eliminate the mercury, and finally, by a process fully described in the paper, pure hydrogen was obtained. The strata now showed no blue whatever, and no mercury lines in the spectrum. They were all pink and gave strong hydrogen lines. If the tube were left overnight connected to the pump, the blue colour appeared in the strata in the morning. If a variable resistance be put in series with the vacuum tube showing, with no resistance interposed, blue and pink strata, then as this resistance is gradually increased the blue colour fades away and soon only pink is seen. Spectroscopic examination again showed that in the parti-coloured strata both mercury and hydrogen were present, while in those of pure pink, while mercury could still be traced, hydrogen was more prominent. These experiments show that the blue colour is due to the presence of traces of mercury. The results with the variable resistance are explained thus: For the same exhaustion hydrogen conducts better than mercury vapour. With a strong induction-spark at a certain reduced pressure the conductivity of the pure hydrogen is insufficient to carry the whole current, and some of it, therefore, is conducted by the mercury vapour. The blue colour then drowns the feebler colour due to hydrogen. But with resistance inserted the current is so weakened that the hydrogen can carry the whole of it, and the blue of the mercury is not seen. The author's explanation of the faces on the pink discs is briefly as follows : Stratifications in mercury vapour are much more difficult to produce than those in hydrogen or other diatomic gases. The hydrogen strata form an anchorage for the mercury, each hydrogen luminosity having a little blue glow of mercury hanging on to it, whereas, if there were no hydrogen present, no mercury would be seen. The pink and blue luminosities show where the electrons and gaseous atoms meet. The dense mercury atom is not driven back so much as the lighter hydrogen atom—hence the blue front to the pink strata. A slight reduction in pressure suffices to break the adhesion between the mercury and hydrogen : then the mercury vapour diffusing along the tube meets the electrons from the negative pole and is swept back to the head of the hydrogen strata and becomes apparent as a single button of blue light. In conclusion, the author points out that "electrons" are the same as that to which he applied the name "radiant matter" twenty years ago. W. C. H.

1353. *The Doppler Effect and Reversal in Spark Spectra.* **J. F. Mohler.** (Astrophys. Journ. 15. pp. 125–128, March, 1902.)—The author attempts to measure the velocity of the metallic particles driven from the electrodes when the spark is passing between them. The electrodes were of different metals placed in a line perpendicular to the plane of the slit. The spark was first observed when the particles were approaching the slit, and then the electrodes were rotated through an angle of 180°, and the spark again observed. The displacement due to motion of the particles in the line of sight would thus be doubled. Photographs were taken of the spectrum of the spark under the two conditions with a grating, and are reproduced in the paper. The displacement due to the Doppler effect is very small, and the lines are too wide and shaded to allow of any accurate measurements of the velocity. This broadening of the lines is probably due to the rapid decrease in the velocity of the particles owing to repeated collisions very soon after leaving the electrodes, so that an average velocity only was obtained of the order of 0·37 km. per second against Schenk's value of 2·5 km. per second. The most interesting result is the reversal of certain lines, notably the magnesium lines at $\lambda = 2795$, 2802, and 2852, when the spark was going away from the slit; when the spark was coming towards the slit no reversal took place. E. C. C. B.

1354. *Spectrum of the Enclosed Arc.* **L. Bell.** (Elect. World and Engineer, 39. p. 195, Feb. 1, 1902.)—The spectrum of the enclosed arc, whether direct or alternating current, consists almost entirely of the carbon bands with the faintest possible continuous spectrum. E. C. C. B.

1355. *Auxiliary Electrode in Röntgen Ray Bulbs.* **C. E. S. Phillips.** (Roentgen Ray, Archives, 6. pp. 48–54; Discussion, p. 54, Feb., 1902. Paper read before the Roentgen Society, Jan. 2, 1902.)—If an auxiliary electrode is used connected to the anode it should stand behind the antikathode, preferably above it. It is helpful in steadying the discharge and in making the flow of anodic particles more symmetrical about the axis. Its electrostatic action in attracting irregularly moving streams of electrified gas towards it is its greatest function; it tends, on the other hand, to make the condition of the discharge slightly more critical by the additional capacity which it introduces into the circuit: it does not begin to exert an appreciable influence until the gas within the bulb is exceedingly rare, and generally its use becomes more evident after a while when the vacuum has become better. A. D.

1356. *Kathode Discharge in a Magnetic Field.* **H. Pellat.** (Comptes Rendus, 134. pp. 697–700, March 24, 1902.)—The author has shown [see Abstract No. 1094 (1902)] that in an intense magnetic field the ordinary kathode flux (called by him the flux A) delineates the tube of force having the kathode as base. This might be supposed due to the fact that in response to electromagnetic force these rays are wrapped in spiral form round the lines of magnetic force. The author now describes experiments to show that this is not the true explanation of the phenomenon. He uses a straight tube whose axis is horizontal and inclined at 45° to the magnetic field, which is also horizontal. The experiments range from a pressure of 0·7 mm. to 0·01 mm., with magnetic field intensity varying from 140 to 5,000 c.g.s. For a field of 140 units the action observed is almost that which would be produced by the electromagnetic force alone, the kathode radiation curving up or down according to the sense of the field, its extremity meeting the glass near the vertical plane V through the axis of the tube. As the field increases, the extremity of the kathode pencil simply becomes farther and farther removed from the plane V until it finally lies in a horizontal plane through the axis of the tube; the pencil now delineates the tube of force having the kathode for base, the distinctness of the walls of the tube increasing with the field. If the effect in intense fields were due to wrapping of the kathode rays round the lines of force, then on increasing the field from 140 units we should see the extremity of the pencils describe a large number of narrower and narrower spirals, till each ray represented the line of force embraced by it. The author explains the phenomenon by supposing that the particles constituting the kathode rays experience friction in a magnetic field, the friction being much less in the direction of the lines of force than at right angles to them. That something analogous to friction exists he has proved experimentally as follows: When the pressure is so great that in zero magnetic field the rays do not reach the glass, then in a magnetic field the pencil contracts both along and at right angles to the direction of the field, but considerably more in the latter direction. As the delineation of a tube of force by the flux is as clear in a uniform as in a non-uniform field, the friction cannot be attributed to Foucault currents in the interior of the particles. W. S.

## ELECTRICAL PROPERTIES AND INSTRUMENTS.

1357. *Electrical Resistance of Steel and Pure Iron.* **C. Benedicks.** (Öfvers. Kongl. Vet. Akad. Stockholm, Förh. 59. No. 2. pp. 67–75, Feb. 12, 1902.)—An extensive series of resistance measurements on eight specimens of Gysinge steel with different percentages of carbon and other impurities leads to the following results:—1. Equivalent portions of various substances dissolved in iron will augment its resistance by equal amounts, as experiments show for the case of C, Si, and Mn, and as may be derived from Wedding's results for the case of P, one dissolved atom per 100 atoms of solution raising it by 5·9 microhms/cm$^3$, in accord with Le Chatélier's measurements. 2. A definite carbide is not found to have any noticeable influence on the resistance of iron. The author, however, suggests that other sorts of steel may exhibit a behaviour somewhat different. 3. Non-tempered steel with 0·45 — 1·70 per cent. C holds 0·27 per cent. C in the dissolved state. Such steels are therefore made up, not of carbide and pure iron, as hitherto supposed, but of a carbide and a 0·27 per cent. solution of carbon in iron, this solution probably being identical with Ostwald's "sorbite." 4. The resistance of steel is represented with great accuracy by the formula $\sigma = 7{\cdot}6 + 26{\cdot}8\,\Sigma C$, ΣC being the sum of the percentages by weight of the "temper carbon" and the value, reduced to carbon, of the remaining substances dissolved. A. G.

1358. *A Modification of Mance's Test.* **J. H. Stephens.** (Electrician, 48. pp. 905–906, March 28, 1902.)—Two tests with different current strengths eliminate the error due to earth current, firstly, by altering battery power or resistance in battery circuit; secondly, by altering resistance in ratio arms. The author proposes another method, viz., by inserting a resistance in the line circuit when taking the second test, and keeping ratio arms, battery power, and resistance in the battery circuit the same for each test. By making the inserted resistance equal to that of ratio arm *a*, a simple and handy formula is evolved for either even or uneven ratios, which is shown in the paper with diagram. E. O. W.

1359. *Measurement of Insulation Resistance.* **P. Charpentier.** (Écl. Électr. 30. pp. 229–238, Feb. 15, 1902.)—The method of measuring insulation resistance by the loss of charge of a condenser is open to many objections: the pressure on the dielectric is variable, and the time of electrification is indefinite. Further, condensers are not generally available which are capable of withstanding the pressures at which the insulation should be tested, and their insulation resistance may be comparable with that of the dielectric to be tested. The author proposes to avoid these sources of error by forming a condenser of the dielectric. This may have a very small capacity, as high pressures can then be employed. The condenser is charged and left insulated for a time sufficient for the insulation resistance to have reached a constant value. It is then discharged through a galvanometer, and the process is repeated, taking a second discharge after a longer interval. If the capacity of the condenser be known, the resistance may be calculated from the ordinary formula for the loss of charge. The author then discusses at length the variation of resistance with time of electrification, and recommends the measurement after five or six minutes, when the resistance has become constant. G. H. B.

1360. *Capacity of Condenser per Unit of Length.* **K. R. Johnson.** (Öfvers. Kongl. Vet. Akad. Stockholm, Förh. 59. No. 2. pp. 53–57, Feb. 12, 1902.)—In a previous article the author had regarded the capacity of a conducting wire per unit of length as a constant; as, however, this is only approximatively true, a more thorough investigation is made in this paper, the problem being limited to determining a surface of revolution characterised by the property of rendering constant the capacity per unit of length. The author thus shows that this really applies to an ellipsoid of revolution, the constant value of the capacity depending only on the eccentricity of the generating ellipse. Hence, in the case of a wire whose thickness decreases towards the ends, this proposition will be rigorously true, while for an ordinary wire with constant radius, the surface becoming larger than that considered above, the capacity will increase towards the ends. A. G.

1361. *Determination of Dielectric Constants of Crystals in Uniform Fields.* **R. Fellinger.** (Ann. d. Physik, 7. 2. pp. 333–357, Feb., 1902. Extract from the Munich Thesis.)—The chief results of this research are summarised in the following table:—

| Substances. | Dielectric Constants. |
|---|---|
| Quartz | 5·0561, 4·6946. |
| Tourmaline | 6·5382, 7·1284. |
| Calc spar | 7·5603, 8·4917. |
| Baryta | 6·9736, 10·0877, 6·9956. |
| Arragonite | 6·0111, 9·1443. |
| Sulphur (cast) | 4·0487. |
| Paraffin (cast) | 2·4574. |

E. H. B.

1362. *Electric Dispersion in Dielectrics.* **J. Kossonogoff.** (Phys. Zeitschr. 3. pp. 207–208, Feb. 15, 1902. Habilitation Paper, Kiew, 1901.)—Two parabolic mirrors of cardboard are fixed above one another. They are to reflect waves of a definite wave-length only, and are hence inlaid, parallel to the focal line, with strips of tin-foil; the lengths of these strips were varied in the different sets of experiments. A Righi vibrator and a coherer were used, and the minimum action of the coherer was observed resulting from the interference of the two waves passing through unequal heights of the respective dielectric, liquid paraffin, petroleum, naphtha oil, turpentine, benzene, castor oil. The first five displayed weak normal electric dispersion; the castor oil showed a certain anomaly; this may have been due to water, from which castor oil is hardly ever free. H. B.

1363. *Electrical Testing of Materials.* **P. Holitscher.** (Elektrotechn. Zeitschr. 23. pp. 147–151, Feb. 20, and pp. 170–174, Feb. 27, 1902.)—The author describes the nature of the tests to which Lahmeyer & Co. submit the various materials employed in their manufacture.

*Iron.*—The hysteresis loss in sheet iron is determined for $B = 10{,}000$ at 50 ∿, in watts per kilo. If the loss exceeds 4·4 for 0·5 mm. sheet the author considers the iron should be rejected. A table between B and H is given for specimens of cast steel from three different firms.

*Copper.*—Directions are given for measuring the conductivity of bare copper. Copper is very uniform in specific gravity; specimens from eleven firms varied only between 8·91 and 8·95, so that the mean section can safely be determined by weighing a given length and assuming a specific gravity of 8·93. In flat strip the edges are always rounded, and the section is consequently less than that calculated from the dimensions. The difference is of the order of 3 per cent. A formula is given from which the true section can be calculated to within about ½ per cent.; if $b$ be the breadth and $a$ the thickness the section is $ab - 0{\cdot}35\,a$. Supplies of copper often differ considerably from the size specified; wire supplied by four firms showed differences of from 7·4 to 15 per cent. of the sizes ordered. The author considers that 3 per cent. divergence is a sufficient margin to allow for solid copper and 6 per cent. for stranded. Cast copper is very variable in quality. Specimens free from blow-holes generally have a low conductivity, and the author has found differences of 100 per cent. in the conductivity of different specimens, although the measurements were made on portions comparatively free from blow-holes.

*Insulated Wires.*—The author agrees with the recommendations of the Verband Deutscher Elektrotechniker that insulation should be tested by the slope of potential it will stand without rupture, and not by the insulation resistance.

*Fuses.*—The author tests these by increasing the current by steps, keeping it for one minute at each value. The maximum and minimum currents taken by a number of pieces and expressed in percentages of the rated value gives a clear indication of the uniformity of the fuses.

*Insulating materials* should be tested by the pressure they will stand, applied between plates and not points. Measurements should be made with the material dry, and with it damp and at different temperatures. Numerous figures are given relating to tests on various materials. The paper concludes with some recommendations on the testing of instruments and meters.

G. H. B.

**1364.** *New Type of Galvanometer.* **W. Einthoven.** (Archives Néerlandaises, 6. pp. 625–633, 1901.)—The author discusses the condition of maximum sensibility of a d'Arsonval galvanometer, the sensibility being taken to be the deflection in mm. on a scale at a distance of 1 m., produced by a current of $10^{-6}$ amperes, with an internal resistance of 1 ohm and a period of 5 seconds. The sensibility thus defined is independent of the controlling force and of the winding of a coil of given size, and the author shows it to be a maximum for a coil of as few turns as possible and of the finest wire. In practice the weight of the mirror would falsify this conclusion, but the author, in constructing his galvanometer, dispenses with a mirror and follows the above principle as closely as possible by stretching a silvered quartz thread, $2{\cdot}1\,\mu$ in diameter and 13 cm. long, in a magnetic field of 30,000 units, and projecting a magnified image of the wire on a scale. A current of $1{\cdot}8 \times 10^{-10}$ ampere could be measured, and the galvanometer was dead beat, attaining its full deflection in $\frac{1}{10}$ second. The resistance of the silvered fibre was 20,300 ohms. G. H. B.

**1365.** *Wehnelt Interrupter.* **A. L. Foley** and **R. E. Nyswander.** (Elect. World and Engineer, 39. pp. 373–374, March 1, 1902.)—The various parts of the interrupter are arranged so that they can easily be separated and reassembled in the same relative positions. For this purpose the wooden base of the apparatus is bored out to receive the cell, and it is provided with a vertical tube which is slotted to form a slide for the arm which carries the anode. The platinum wire anode is held in a clamp formed at the end of the rod by two saw-cuts at right angles to each other; the end of the rod is tapered and a thread is cut so that the clamp can be tightened by a threaded metal ring. It was pointed out by Rossi [see Abstract No. 163 (1900)] that if from any fortuitous cause an interrupter should cease working it can often be made to resume by momentarily breaking the circuit. The authors claim to have discovered this before Rossi, and they describe a cut-out arrangement for effecting the break automatically. As regards electrolytes for interrupters, some work better on high and low voltages than the usual 10 per cent. solution of sulphuric acid. The addition of nitric acid to the sulphuric lowers the voltage required to produce interruptions. On a 115-volt circuit the authors use a 10 per cent. solution of sodic sulphite. With a solution of sodic hyposulphite the interrupter ceased working when the secondary of the induction coil was short-circuited, whereas a solution of ammonic nitrate worked best on a short-circuited secondary. R. A.

## ALTERNATING CURRENTS AND MAGNETISM.

**1366.** *Action of Direct-Current Armatures on Alternating Currents.* **H. Poincaré.** (Écl. Électr. 30. pp. 301–310, March 1, 1902.)—Various general theorems arising out of his previous discussion of this question [see Abstract No. 502 (1902)] are discussed mathematically. The effects of making or breaking a circuit in the neighbourhood of a series of other circuits on the electrokinetic energy of the system are calculated. It is shown that unless we know the signs of the various coefficients of mutual induction, &c., we cannot say whether the electrokinetic energy will be increased or diminished. A. R.

**1367.** *Charging Currents in Alternating-Current Circuits.* **H. Andriessen.** (Ann. d. Physik, 7. 2. pp. 369–380, Feb., 1902.)—The author describes in this article a series of experiments made in alternating-current circuits where either large capacities and low frequencies or small capacities and high frequencies were used, and considers the values of the charging current obtained. The author considers also the behaviour of incandescent lamps introduced into similar circuits, or when very high voltages are used, and, lastly, he discusses whether there exists any relation between the voltage, frequency, and danger for the human body, in touching conductors in an alternating circuit. The article is illustrated with diagrams showing the nature of the experiments carried out. The conclusions at which the author arrives are summarised as follows: In an alternating-current circuit of high frequency, a small capacity like a Leyden jar (1 ft. high) introduced into the circuit is sufficient to permit a charging current to pass which should cause a 16-c.p. lamp to burn. Incandescent lamps burn with less current and higher voltage in a high-frequency alternating-circuit than in a direct-current one. With low frequencies the current necessary to make Geissler tubes luminous can pass through the human body without any danger, and, lastly, the human body cannot endure any stronger currents at high frequencies than at low frequencies. (See Elektrotechn. Anzeiger, p. 323, 1898.) L. G.

**1368.** *Alternate-Current Diagrams.* **W. E. Sumpner.** (Inst. Elect. Engin., Journ. 31. pp. 630–631; Discussion, pp. 641–645, March, 1902.)—Mathematical definitions are given of phase angle and power-factor. It is proved that the power-factor can only be unity when the e.m.f. and current waves are similar curves. The fallacy of obtaining a power-factor of unity by means of compensators, and the misleading use of the terms "lag" and "lead" are pointed out. In the discussion the author mentions the necessity of resorting to solid geometry in special cases. A. R.

**1369.** *Analysing Wave-Forms by Resonance Methods.* **H. Armagnat.** (Écl. Électr. 30. pp. 373–385, March 15, 1902.)—Pupin's resonance method of finding the harmonics in alternating-current waves (American Journal of Science, May, 1893), is improved and amplified. Instead of using an electrometer to find out when resonance takes place at the various harmonics, the author uses an oscillograph or a rheograph. This method has also been usefully applied by T. Mather [see Abstract No. 2289 (1901)]. It is shown that a very small error in adjusting for resonance at a particular harmonic affects appreciably the determination of both the amplitude and the phase of the harmonic: hence good results can only be obtained when the speed of the alternator is very regular. It is advisable to have the time constant of the inductive coil in series with the condenser as large as possible. As a rough guide to the quantity of copper required in the coil the following formula may be used: If T be the time constant required in seconds, then the weight of copper required will be $a(100\mathrm{T})^{\frac{3}{2}}$ kg. where $a$ lies between 2 and 3. Oscillograph diagrams of the current are shown when resonance takes place at the fifth, seventh, eleventh, and thirteenth harmonics in the case of a p.d. wave got from a rotary converter. The equation to this curve is approximately—

$$\mathrm{V} \doteq 6{,}500 \sin pt + 136 \sin 5\,pt + 75 \sin\left(7\,pt + \frac{3\pi}{4}\right)$$
$$+ 357 \sin(11\,pt - \pi) + 90 \sin 13\,pt.$$

The curve contains higher harmonics, but their amplitudes are much smaller than those given in the above equation. Instructive diagrams are shown illustrating the effect of the interference of the other harmonics on the oscillograph record when the circuit is adjusted for resonance at a particular harmonic. To get practically continuous variation of the free period of the system an adjustable induction coil of the Ayrton and Perry type is recommended. A. R.

1370. *The Screening Effect of a Conductor on a Parallel Alternating Current.* **T. Levi-Civita.** (Accad. Lincei, Atti, 11. pp. 163–170, Feb. 16; pp. 191–198, March 2; and pp. 228–237, March 16, 1902.)—In the first of these papers the author considers the case of a current in a rectilinear wire, taken as parallel to $x$, of finite or indefinite length, and first as alone in space. The components of vector potential, U V W, are calculated as *retarded potentials* of the form $\int \frac{1}{r} f(t-\mathrm{A}r)d\tau$, where $\frac{1}{\mathrm{A}}$ is the velocity of light. The potential of free electricity, F, is calculated according to the same method. The components of magnetic force, L M N, and those of electric force, X Y Z, are subject to the usual formulæ—

$$\mathrm{L}=\frac{d\mathrm{V}}{dz}-\frac{d\mathrm{W}}{dy}, \text{ \&c., and } \mathrm{X}=-\frac{d\mathrm{F}}{dx}-\mathrm{A}\frac{d\mathrm{U}}{dt}, \text{ \&c.}$$

They further satisfy, as the author has previously shown, the conditions—

$$\nabla^2\mathrm{F}-\mathrm{A}\frac{d^2\mathrm{F}}{dt^2}=0,\quad \nabla^2\mathrm{U}-\mathrm{A}\frac{d^2\mathrm{U}}{dt^2}=0, \text{ \&c.}$$

It is further assumed that, if $u(t)$ denote the intensity of the current at any point at time $t$, then the integral $\int_0^\infty \frac{u(t-\mathrm{A}x-\mathrm{A}\lambda)-u(t-\mathrm{A}x)}{\lambda}d\lambda$ where $x$ is the abscissa of the foot of the perpendicular on the current from the point P considered, has a determinate value. Here $\lambda$ is the sum of the distances of a point $x$ in the wire from P and from $x$. For the rectilinear current alone in space, the writer arrives at the conclusion that if Q be the foot of the perpendicular from P on the wire, the electromagnetic forces are the same at any instant as if the current were constant, having at each point of the wire the intensity which it has at Q at the instant considered. He finds further $\mathrm{F}=\mathrm{U}$. He next introduces into the field a conducting plane or screen parallel to the current, taken for the plane $z=d$, of specific resistance R, the induced currents in which give rise to retarded potentials, $\mathrm{U}_1$, $\mathrm{V}_1$, $\mathrm{W}_1$, $\mathrm{F}_1$, subject to the same general conditions, as U, V, W, F, the total potentials at any point in the field being now $\mathrm{U}+\mathrm{U}_1$, $\mathrm{V}+\mathrm{V}_1$, &c., and for the current at a point in the screen we have $\mathrm{A}u_1=-\frac{1}{2\pi}\frac{d\mathrm{U}_1}{dz}$, $\mathrm{A}v_1=\frac{1}{2\pi}\frac{d\mathrm{V}_1}{dz}$, and the expressions for the electric forces $x$ $y$ give—

$$\frac{d(\mathrm{F}'+\mathrm{F}_1)}{dx}+\mathrm{A}\frac{d(\mathrm{U}'+\mathrm{U}_1)}{dt}=\frac{\mathrm{AR}}{2\pi}\frac{d\mathrm{U}_1}{dz}$$

$$\frac{d(\mathrm{F}'+\mathrm{F}_1)}{dy}+\mathrm{A}\frac{d(\mathrm{V}'+\mathrm{V}_1)}{dt}=\frac{\mathrm{AR}}{2\pi}\frac{d\mathrm{V}_1}{dz}$$

In the second paper the author assumes the current parallel to the screen to be sinusoidal, and of the form $u(t-\mathrm{A}x)=\mathrm{I}_0\epsilon^{i\left(\omega-\frac{\pi}{2}\right)}$, in which $i=\sqrt{-1}$, and $\omega = 2\pi n(t - \mathrm{A}x) + a$, where $n$ denotes the frequency, and $\mathrm{I}_0$, $n$, and $a$ are real. The potentials at any point corresponding to this current are—

$$\mathrm{U}' = 2\mathrm{I}_0\epsilon^{i\left(\omega - \frac{\pi}{2}\right)} \log \frac{1}{d}, \; \mathrm{V}' = 0, \; \mathrm{W}' = 0, \; \mathrm{F}' = \mathrm{U}',$$

of which, to find the potentials on the screen, we take the real parts. Whence we have—

$$\mathrm{F}_1 = 2\mathrm{I}_0\epsilon^{i\left(\omega - \frac{\pi}{2}\right)}\mathrm{F}_2, \qquad \mathrm{U}_1 = 2\mathrm{I}_0\epsilon^{i\left(\omega - \frac{\pi}{2}\right)}\mathrm{U}_2, \qquad \mathrm{V}_1 = 2\mathrm{I}_0\epsilon^{i\left(\omega - \frac{\pi}{2}\right)}\mathrm{V}_2,$$

$\mathrm{F}_2$, $\mathrm{U}_2$, $\mathrm{V}_2$, being functions of $y\,z$. The solution of the problem consists in finding the three harmonic functions $\mathrm{F}_2$, $\mathrm{U}_2$, $\mathrm{V}_2$, of $y$ and $z$ to satisfy the equations—

$$\frac{d^2\mathrm{F}_2}{dy^2} + \frac{d^2\mathrm{F}_2}{dz^2} = 0, \quad \frac{d^2\mathrm{U}_2}{dy^2} + \frac{d^2\mathrm{U}_2}{dz^2} = 0, \quad \frac{d^2\mathrm{V}_2}{dy^2} + \frac{d^2\mathrm{V}_2}{dz^2} = 0 \ldots\ldots\ldots\ldots\ldots (1)$$

$$2\pi n\mathrm{A}i(\mathrm{F}_2 - \mathrm{U}_2) + \frac{d\mathrm{V}_2}{dy} = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

and—

$$\left.\begin{aligned} 2\pi n\mathrm{A}i(\mathrm{F}_2 - \mathrm{U}_2) + \frac{\mathrm{AR}}{2\pi}\frac{d\mathrm{U}_2}{dz} &= 0 \\ \frac{d}{dy}\left(\mathrm{F}_2 + \log\frac{1}{d}\right) + 2\pi n\mathrm{A}i\mathrm{V}_2 - \frac{\mathrm{AR}}{2\pi}\frac{d\mathrm{V}_2}{dz} &= 0 \end{aligned}\right\} \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

This problem receives a general solution for $\mathrm{F}_2$, $\mathrm{U}_2$, $\mathrm{V}_2$ separately. As an approximate form it is found that $\mathrm{F}_2 = -\log\frac{1}{\mathrm{D}}$, with $\mathrm{D}^2 = y^2 + (z + d)^2$, from which $\mathrm{U}_2$ and $\mathrm{V}_2$ are determinable. These values, however, substituted in the formulæ for U V W, X Y Z, are not convenient for numerical calculations.

In the third paper the author returns to the value of $\mathrm{U}_2 - \mathrm{F}_2$ given in II., namely, $\mathrm{U}_2 - \mathrm{F}_2 = i\int_0^\infty \epsilon^{-g\lambda}\frac{d\log\frac{1}{r}}{dz}\,d\lambda$ (equation 15 of Note II.). The second member of this equation has an essential singular point when $g = \infty$. It is shown that for real and positive values of $\frac{1}{g}$ the expression may be expanded by Taylor's theorem, and superior limits found for every remainder. By this means approximate values of $\mathrm{F}_2$, $\mathrm{U}_2$, $\mathrm{V}_2$ are found, approaching the exact value as the number of terms of the Taylor series taken into account is increased.

He then finds superior limits for the errors with which the electromagnetic forces of the field can be affected by the use of the asymptotic approximations. The result given is, that as regards the electric forces on one side of the screen, we may without sensible error take $\mathrm{U}_2 - \mathrm{F}_2 = 0$. On the far side of the screen the electric forces are sensibly cut off by the screen. Also that on the far side of the screen the magnetic forces are reduced in a certain proportion. S. H. B.

**1371.** *Measurement of Phase-difference.* **O. Queisser.** (Elektrotechn. Zeitschr. 23. pp. 102–103, Feb. 6, 1902.)—When an alternator with projecting pole-pieces is viewed in the light of an arc lamp in the circuit of the machine, the pole-pieces appear stationary. The apparent position of the pole-pieces relative to the stationary part depends, however, on the phase-difference between the e.m.f. and current of the arc lamp, and the author proposes to measure this phase-difference by observing the angular displacement of the centres of the armature and field-poles. If the arc lamp be connected in series with the machine, the displacement measures the phase-difference in the circuit. G. H. B.

1372. *Magnetic Properties of Very Thin Sheets of Iron and Nickel.* **C. Maurain.** (Journ. de Physique, 1. pp. 151–156, March, 1902.)—The author gives the results of an examination of the magnetic properties of thin deposits of iron or nickel made on kathodes of brass, silver, copper, gold, and platinum in a magnetic field. It is found that the nature of the kathode has no influence on the results obtained. In the case of iron, the lowest limit of thickness of a layer having definite magnetic properties is about 88 $\mu\mu$ ($10^{-6}$ mm.). The slight initial deviation from a straight line, of the curve representing the deflection of the magnetometer as a function of the time, practically disappears if the strength of field is sufficiently intense, *i.e.*, the magnetic saturation of all the layers corresponds with the same value of the intensity of magnetisation. In the case, however, of nickel, the limiting magnetic layer of which has a thickness of about 200 $\mu\mu$, the intensity of magnetisation of the superficial layers is greater than that of the lower layers. The details of the various experiments are given. T. H. P.

1373. *Calorimetric Properties of Ferro-magnetic Bodies.* **B. V. Hill.** (Elect. Rev. N. Y. 40. pp. 403–404, March 29, 1902.)—Many alloys containing Ni, Co, Mn, Fe were tested as to susceptibility and specific heat at various temperatures from —180° C. to + 1,000° C., and after varying previous treatment. The conclusion arrived at is that the greater the permeability the less is the specific heat. P. E. S.

1374. *Secular Variations of Terrestrial Magnetism.* **V. Raulin.** (Annal. Chim. Phys. 25. pp. 289–307, March, 1902.)—This paper is mainly an historical summary. The author adheres to the view which he expressed in 1866, that the magnetic north pole revolves about the geographical pole in about 600 years, approximately on the 70° lat., though the advance of the line of zero declination in North America seems to indicate that the pole is now in lat. 75°. At Paris the declination needle has during the 75 years since 1814 receded exactly as much to the east as it had advanced to the west in the 77 years before 1814. That the inclination is still decreasing would be in accordance with his view, which is that an eccentric magnetic mass of a greater density than the earth's centre lags behind the earth's crust by about 1/600 in the diurnal revolution. He rejects the conclusions which Folgheraiter [see Abstracts Nos. 839 and 1039 (1899)] had drawn from the examinations of ancient Etruscan and other vases. H. B.

1375. *The Relation of the Magnetic Properties to the Electric Conductivity of Magnetic Substances.* **W. Gumlich.** (Elektrotechn. Zeitschr. 23. pp. 101–102, Feb. 6, 1902.)—Gumlich and Schmidt have shown [see Abstract No. 2177 (1901)] that generally small hysteresis loss is accompanied by high electric conductivity, and therefore great dissipation of energy due to Foucault currents, and described experiments with materials in which the reverse is the case. In the present paper the author discusses the experiments published by Barrett, Brown & Hadfield (Scientific Transactions of the Royal Society of Dublin, Vol. 7, Ser. 2), proving that the magnetic quality of iron can be improved, while the Foucault losses are simultaneously diminished, by the addition of small quantities of certain substances. He introduces corrections neglected in the original paper, and calculates Steinmetz's coefficient $\eta$ connecting the hysteresis loss E in ergs per c.c. with the induction by the equation $E=\eta . B^{1·6}$. The results are given in the following tables :—

### TABLE I.

| Specimen | Percentage of Substances other than Iron. | | | Resistance per mm /sq. mm. | | Magnetic Qualities. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Al | C | Si | Unannealed. | Annealed. | B for H = 45 | Remanence. | Coercive force. | Max. $\mu$ | Hysteresis loss E. | $\eta$ |
| 1167 D | 0·75 | 0·17 | 0·10 | 0·248 | 0·220 | 16,500 | 11,000 | 2·00 | 2700 | 11,620 | 0·0021 |
| 1167 H | 2·25 | 0·24 | 0·18 | 0.463 | 0·390 | 16,500 | 11,300 | 1·87 | 2950 | 10,960 | 0·0019 |
| 1167 J | 5·50 | 0·22 | 0.20 | 0·781 | 0·700 | 13,410 | 4,500 | 1·43 | 1550 | 6,825 | 0·0017 |
| Iron B | — | 0·03 | 0·14 | 0·111 | 0·109 | 17.480 | 10,600 | 1·66 | 3100 | 11,090 | 0·0018 |

### TABLE II.

| Specimen. | Percentage of Substances other than Iron. | | Resistance per mm./sq. mm. | | Magnetic Qualities. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Si | C | Not Annealed. | Annealed. | B for H = 45 | Remanence. | Coercive force. | Max. $\mu$ | Hysteresis loss E. | $\eta$ |
| 898 E | 2·5 | 0·20 | 0·471 | 0·421 | 16,640 | 8,000 | 0·90 | — | — | — |
| 898 H | 5·5 | 0·26 | 0·688 | 0·652 | 16,480 | 6,900 | 0·85 | 4000 | 6500 | 0·0011 |
| SCJ | 0·07 | 0·028 | 0·105 | 0·102 | 16,750 | 9,400 | 1·66 ? | 2800 | 10,100 | 0·0017 |
| Iron B | 0·03 | 0·14 | 0·111 | 0·109 | 17,480 | 10,600 | 1·66 | 3100 | 11,090 | 0·0018 |

### TABLE III.

| Specimen SCJ. | | | Specimen 898 H. | | |
|---|---|---|---|---|---|
| B | H | $\mu$ | B | H | $\mu$ |
| 600 | 0·37 | 1600 | 1240 | 0·29 | 4200 |
| 3680 | 1·53 | 2400 | 4480 | 1·43 | 3140 |
| 8200 | 2·96 | 2770 | 10520 | 2·66 | 3960 |
| 12,880 | 6·36 | 2030 | 13440 | 6.29 | 2140 |
| 14,400 | 10·17 | 1420 | 13920 | 10·23 | 1360 |
| 15,450 | 14·04 | 1100 | 14560 | 14·15 | 1030 |
| 16,000 | 17·97 | 890 | 14900 | 18·10 | 820 |
| 16,800 | 27·87 | 600 | 15450 | 28·04 | 550 |
| 17,400 | 37·79 | 460 | 16000 | 37·97 | 420 |

W. S.

**1376.** *Magnetism in a Rotating Iron Cylinder.* **E. Wilson.** (Roy. Soc., Proc. 69. pp. 435–449, March 21, 1902.)—An iron cylinder, 10 in. long and 10 in. in diameter, is placed, like the armature of a dynamo, between the poles of a strong magnet. Holes ¼ in. in diameter are drilled into the cylinder in such wise that four coils can be wound round portions of the iron at various distances from the axis. The coil ends are brought out through the axles to a terminal board. Each coil has a d'Arsonval galvanometer in its circuit. Hence, when the cylinder is rotated slowly, magnetism diffuses from the outside to the axis of the cylinder; the induction current which arises in each coil is measured on its galvanometer. The independent variables are (1) the whole flux between the poles; (2) the speed of rotation, the periodic times being 360, 180, 20, 45, 22·5 secs. The tables show how screening by the outer layers varies with different speeds. Alternating magnetic forces are also used. By the light of these researches the author briefly considers the three important special cases: (1) The earth's rotation in connection with the 960 year period of terrestrial magnetism; (2) the 1 mm. plate as used in dynamo armatures; (3) an iron molecule $10^{-7}$ cm. thick. In each case the author can use his experimental results; for, when the dimensions of the rotating cylinder are changed $n$ times, then, if the periodic time of rotation is changed $1/n^2$ times, the induction in like parts of the cylinders remains identical. P. E. S.

**1377.** *Kirchoff's Theory of Magnetostriction.* **S. Sano.** (Phys. Rev. 14. 158–170, March, 1902.)—Kirchoff's theory is given in Sitzberichte Berlin, p. 137, 1884, Wied. Ann. 24. p. 52, 1885, and Gesammelte Abhandlungen Nachtrag Leipzig (1891). In the present paper the theory is extended to the case where the susceptibility $k$, and two strain coefficients $k'$ and $k''$, are functions of the strength of the magnetising force. The writer retains the other assumptions made by Kirchoff, that the solid is initially isotropic, and free from hysteresis and time lag, and that the intensity of magnetisation (A B C) is a function, not only of the magnetising force H, but also a linear function of the strain. He obtains expressions for (A B C) which are linear in $k$, $k'$, $k''$, $k'''$, and $k''''$, and then by application of the conditions for the absence of hysteresis, namely $d\mathrm{B}/dx - d\mathrm{C}/d\beta = 0$ &c., where $\alpha\ \beta\ \gamma$ are the components of the magnetic force, he finds $k''' = \frac{1}{2}\mathrm{H}dk''/d\mathrm{H}$ and $k'''' = 0$. A, B, C, are thus found as functions of $k$, $k'$, and $k''$. These reduce to Kirchoff's values by making $dk''/d\mathrm{H} = 0$. The result is that on Kirchoff's magnetisation is superposed another whose direction is parallel to the magnetic force, and whose intensity is proportional to $dk''/d\mathrm{H}$, and to the linear dilatation in the direction of the magnetic force. The writer then gives a new investigation of the mechanical forces acting on the solid, from which it appears that Kirchoff's expressions require some modification when $k$ and $k'$ are functions of the strength of the magnetising force. S. H. B.

## REFERENCE.

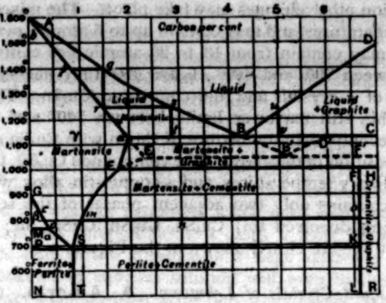
**1378.** *Ionisation of Gases.* **J. Stark.** (Ann. d. Physik, 7. 2. pp. 417–439, Feb., 1902.)—This paper is a continuation of a previous theoretical paper [see Abstract No. 845 (1901)] on ionisation. It treats of ionisation by collision of ions, of the energy of ions, the work done in ionising them and the efficiency of ionisers, of the effects of temperature and electric force, of stratified and unstratified ionisation in the interior of a gas, and of ionisation at the bounding surfaces of the gas. W. E. T.

## CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

**1379.** *Quantitative Determination of Nitrogen.* **A. Lidoff.** (Jurn. Russk. Fisik. Chimicesk. Obscestva, 34. 1. pp. 42–52, 1902.)—No method of determining directly the percentage of nitrogen in a gaseous mixture has hitherto been devised. The author here describes one which yields fairly satisfactory, though not really accurate, results, based upon the absorbing properties of a mixture of pulverised magnesium and lime. Details of experiments and illustrations of apparatus are given, with tables, from which it appears that the mean limit of accuracy is 93–94 per cent., though in some cases it may be as low as 90 per cent. A. G.

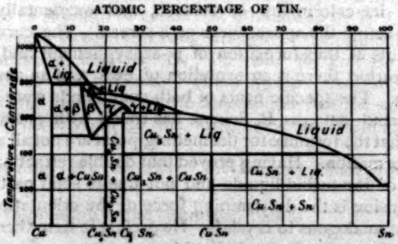
**1380.** *Ebullioscopic Molecular Weight Determinations in Volatile Solvents.* **G. Oddo.** (Accad. Lincei, Atti, 8. pp. 244–289, 1899 ; 11. pp. 12–20, Jan. 5 ; p. 85, Jan. 19; and pp. 130–137, Feb. 2, 1902.)—The boiling-point apparatus finally adopted for these determinations was the ordinary one, except that the inverted condenser attached to the boiling-tube could be turned through an angle of 180° after a reading of the b.p., and was then in position for the distillation of part of the solution. The distillate was in each case collected and analysed ; the analysis gave the composition of the superincumbent vapour during the determination of b.p., and enabled a correction to be made for any volatility of the dissolved substance with the solvent. The molecular weight was obtained from the formula, $M = c(g_2 - g_1)/d$, where $c$ is the molecular constant for the solvent, $g_2$ the concentration of the solution, $g_1$ the concentration of the vapour, and $d$ the elevation of boiling-point. The results of the author's experiments are summarised in the following statements: 1. Iodine in boiling solutions, in carbon bisulphide, benzene, and ethyl alcohol has biatomic molecules, whereas in chloroform and carbon tetrachloride we find, in addition to the biatomic, also tetratomic molecules. There appears to be no connection between the colour of the iodine solutions and the complexity of the grouping of the atoms of iodine. 2. Similar results are obtained with some inorganic halogen anhydrides which tend to polymerise in several solvents at the b.p. This is markedly so with phosphorus oxychloride in carbon tetrachloride and in benzene ; less so with thionyl chloride in chloroform or with phosphorus oxybromide or thiophosphoryl chloride in benzene ; much less so with protochloride of sulphur in benzene. It is to be noted that all these anhydrides present cryoscopically, in benzene solution, simple molecules, even in fairly strong solutions. 3. Attempts to isolate polymeric forms of certain organic derivatives of $POCl_3$ were unsuccessful. The compound $C_6H_5NH.POCl_2$ shows in benzene solution a considerable tendency to polymerise, whereas the phenolic ethers, $C_6H_5O.POCl_2$ and $(C_6H_5O)_3PO$ give, in boiling benzene solutions, simple molecules. 4. Sulphur in boiling carbon tetrachloride gives octatomic molecules. 5. Phosphorus pentachloride in carbon tetrachloride has the formula $PCl_5$. 6. The mono- and tri-chlorides of iodine—probably on account of dissociation—lower the boiling-point of carbon tetrachloride. D. H. J.

**1381.** *Alloys.* **W. C. Roberts-Austen** and **T. K. Rose.** (Soc. Arts, Journ. 49. pp. 846–854, Nov. 8; and pp. 858–863, Nov. 15, 1901, Cantor Lectures.)—The papers on which the lectures are based have many of them been already abstracted; the important equilibrium curves for iron and carbon given by Roozeboom [see Abstract No. 2275 (1900)] to explain the experimental results of Roberts-Austen are given in a compact form and are reproduced herewith.



The general characteristics of eutectic alloys are summarised as follows: When examined under high magnifications they are generally seen to consist of alternate bands of light and dark material. *Perlite,* the eutectic alloy of iron and carbon, consists of *curved bands* of hard cementite ($Fe_3C$) standing out in relief, with soft ferrite forming furrows between. The eutectic alloy of silver and lead consists of *straight bands* of the two metals. That of iron (89·8 per cent.) and phosphorus (10·2 per cent.) has a *cellular* structure, whilst that of lead (87·3 per cent.) and antimony (12·7 per cent.) has a *spherulitic* structure. Occasionally on slow cooling a crystalline structure is developed. T. M. L.

**1382.** *Constitution of Copper-Tin Alloys.* **C. T. Heycock** and **F. H. Neville.** (Roy. Soc., Proc. 69. pp. 320–329, Jan. 31, 1902.)—In addition to the pure metals, evidence has been obtained of the existence of three compounds, probably CuSn, $Cu_3Sn$, and $Cu_4Sn$, of which the last cannot exist in contact with the liquid, and of three types of solid solutions of tin in copper, which are named $\alpha$, $\beta$, and $\gamma$. Unlike the iron-carbon alloys (preceding Abstract), the pure metal only exists in one modification, and only becomes trimorphous when mixed with tin. The equilibrium between the eight possible phases (one



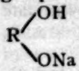
liquid and seven solid) is represented by a diagram similar to that given by Roozeboom for the iron-carbon alloys. This shows that as the percentage of tin is increased the crystals which separate from the liquid are successively the mixed crystals $\alpha$ $\beta$ and $\gamma$, the compounds $Cu_3Sn$ and CuSn, and finally (if there are less than 2 atomic per cents. of copper in the liquid) pure tin. After solidification other changes may take place. The mixed crystals $\alpha$ are stable at all temperatures, and may contain up to 5 atomic percentages of tin. The $\beta$ crystals may contain from 13 to 20 atomic per cents. of tin, but are only stable between 790° and 480°; below 480° they decompose completely into a mixture of $\alpha$ crystals and the compound $Cu_4Sn$. The $\gamma$ crystals are stable only within still narrower limits, between 740° and 580°, and when cooled slowly decompose into a mixture of $Cu_3Sn$ with $Cu_4Sn$ or CuSn, according to the composition of the alloy. The compounds $Cu_4Sn$, $Cu_3Sn$, and CuSn are stable at ordinary temperatures, and a copper-tin alloy which is allowed to cool slowly contains only two adjacent phases of the series $\alpha$ (ordinary copper containing dissolved tin) $Cu_4Sn$, $Cu_3Sn$, CuSn, Sn; the boundaries which separate these are clearly shown in the Figure. T. M. L.

1383. *The Liquid Crystals of Lehmann.* **A. Amerio.** (N. Cimento, 3. pp. 281–297, Nov.-Dec., 1901. Communicazione al Congresso di Fisica, Bologna, Sept., 1901.)—The substances taken were p.-azoxyphenetol and p.-azophenetol; the latter, which has not previously been studied in this direction, melts at 149° into a turbid liquid becoming clear at 160°. The crystallised solid is strongly birefractive and also dichroic, and in polarised light appears intense yellow or clear green. When melted under the microscope it presents the same phenomena up to the transformation-point 160°, above which it is singly refractive. On gradual cooling, at the point of transformation minute drops, brilliant in the crossed nicols, begin to separate, increasing and uniting to form a parti-coloured field traversed by faint lines. Lehmann attributed [Abstracts Nos. 1876 and 2472 (1900)] this group of phenomena to the "molecular directing force" (Richtkraft) and the resultant orientation in crystals persisting under certain conditions in the liquid state, and that therefore the word "solid" must be omitted from the definition of a crystal. Quincke gave another explanation in the formation of a pellicle of very minute solid crystals, and Tammann [Abstracts Nos. 1352 and 1761 (1901)], pointed out that some emulsions of non-crystalline bodies gave similar appearances. The author re-examines the question, using an apparatus similar to the ice-calorimeter of Bunsen, and incidentally describes his method of projecting the appearances on a screen. The curves demonstrate that at the points of transformation of p.-azoxyphenetol and p.-azophenetol from clear to turbid there is an evolution of heat, and an absorption on the reverse change. The specific heats of both compounds were less in the clear than in the turbid state, as R. Schenk has found with p.-azoxyanisol. The author shows that the formulæ for the melting-point are not all applicable to the point of transformation. Having proved that double refraction and dichroism are properties of the turbid liquids and not due to solid particles, he argues that surface tension is the determining force of the orientation, and that the droplets are not analogous to crystals. He prefers to term them, with Retgers, simply birefractive and anisotropic liquids. S. R.

1384. *Existence of Racemic Compounds in Solution.* **G. Bruni** and **M. Padoa.** (Accad. Lincei, Atti, 11. pp. 212–217, March 2, 1902.)—The existence of racemic compounds has so far been proved only for the solid state;

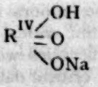
the authors endeavour to show their existence in solution by a cryoscopic examination of the solutions of a racemic compound (dimethyl diacetylracemate), in presence of a large excess of one of the components of the racemate (dimethyl diacetyltartrate). The solvents used were benzene, p.-xylene, ethylene bromide, and bromoform. The freezing-point of the solution of the tartrate was first determined; the racemate was then added, and the lowering of the freezing-point ascertained. The molecular weights thus found are (except in the case of the bromoform solutions) considerably higher than those of the simple tartrates; so that we have here some evidence of the existence of racemic compounds in solution. D. H. J.

**1385.** *Nature of Alkaline Solutions of Metal Hydroxides.* **A. Hantzsch.** (Zeitschr. Anorg. Chem. 30. 3. pp. 289–325, 1902.)—(1) The hydroxides of beryllium, zinc, and lead, as well as stannous and germanous hydroxide, are found to behave as weak or extremely weak acids only, their alkaline salts undergoing in aqueous solution in most cases a most advanced hydrolysis and being stable only in the presence of a large excess of alkali. (2) The acid metal hydroxides in aqueous solution will, even in the presence of an excess of alkali, act as mono-basic acids only, the di-basic salts $RO_2Na_2$ being most probably entirely decomposed into mono-salts and free alkali in aqueous solution. The author thinks such statements as would suggest the presence of polyvalent metal ions, *e.g.*, $ZnO_2$, entirely invalid. (3) The strength of the acids of these metals has been determined by two methods, the series, beginning with the weakest, being as follows: $ZnO_1H_2$; $BeO_2H_2$; $PbO_2H_2$; $SnO_2H_2$; $GeO_2H_2$. This series is divided into two groups. Zinc and beryllium hydroxide behave as extremely weak acids, the former deserving hardly this designation. The remainder, however, are well-defined acids, germanous hydroxide being even a weak electrolyte. The formation of salt in an alkaline lead solution is most considerable, and the amount of alkali necessary to dissolve the hydroxide will be so large only because the hydrolysis of alkaline plumbites has to be nearly completely restrained, so as to prevent the precipitation of the slightly soluble lead hydroxide. (4) As regards the relations between the anions and kations of these metals, a somewhat striking phenomenon is noted. Whereas one would expect the negative electro-affinity of an anion to be the smaller, as the positive electro-affinity of the kation formed of the same metal is greater, this electrochemical rule is verified only for such amphoteric electrolysis as are derived from metals of the same group. When ranging these metals according to strength of kations (as established by H. Ley) and, on the other hand, according to the increasing strength of their anions, the following series are obtained: (*a*) Ge; Sn; Be; Pb; Zn. (*b*) Zn; Be; Pb; Sn; Ge. Be and Pb will thus change places. These apparent contradictions will disappear when taking into account the assumption that the salts of the above groups may not correspond to the same structure formulæ, the formula



$$R\begin{matrix}\diagup OH\\ \diagdown ONa\end{matrix}$$

representing only the salts of the zinc-beryllium group, those of the latter group corresponding to the (formiate) type—



$$R^{IV}\begin{matrix}\diagup OH\\ = O\\ \diagdown ONa\end{matrix}$$

Chemical reasons in favour of this hypothesis are adduced, and the possibility is pointed out that these three metals may not exhibit exclusively the latter type in their alkali solutions, the undissociated proportion of hydroxides as generated by an advanced hydrolysis consisting possibly partly or wholly of di-hydroxides $R(OH)_2$. The hydroxides of the second group are considered as pseudoacids formed with intramolecular transpositions in analogy with certain organic bodies. A. G.

1386. *Solubility of Heavy Metal Hydroxides in Sodium Hydroxide.* **J. Rubenbauer.** (Zeitschr. Anorg. Chem. 30. 3. pp. 331–338, 1902.)—Alkali solutions of the hydroxides of beryllium, zinc, and lead, as well as stannous hydroxide, do not contain any definite compounds (as has since been shown by Hantzsch [see preceding Abstract]), the amount of hydroxide dissolved depending greatly on the concentration of the alkali. The percentage of zinc hydroxide (perhaps also of beryllium) first dissolved will exceed the amount corresponding to the stable condition, a portion depending upon concentration being next separated out. The influence of the concentration of alkali on the solubility of those hydroxides is relatively small in the case of beryllium and tin, somewhat greater in that of lead, and most considerable for zinc. There is no proportionality between the concentration of sodium hydroxide and the solubility in question, as there corresponds, in most cases, to a certain concentration of alkali practically either a maximum or a minimum of solubility. This points to the coexistence of two opposite chemical processes, viz., a diminution of alkaline solubility with increase of dilution, according to the hydrolysis of the salts formed increasing with increase of dilution and, on the other hand, a diminution of the alkaline solubility, as the concentration of alkali increases, the latter being possibly a consequence of the metal hydroxides produced being partly anhydrised [see following Abstract] by the concentrated alkali and separating out in that state. The fact that non-dissolved stannous hydroxide will pass into anhydrous stannous oxide on being imbibed with very concentrated sodium hydroxide already at low temperature, and that recently precipitated, moist zinc hydroxide when dried and heated (in accordance with Herz results) will pass into a modification insoluble or very slightly soluble in alkali, affords an evidence of this hypothesis, the latter modification being possibly a product containing less water than the hydroxide recently precipitated and not capable of being analysed in this state. A. G.

1387. *Interpretation of Modifications of Metal Hydroxides.* **A. Hantzsch.** (Zeitschr. Anorg. Chem. 30. 3. pp. 338–342, 1902.)—This is a remark on the two papers dealt with in the preceding Abstracts. The author suggests accounting for the fact that certain metal hydroxides, when recently precipitated, will first dissolve readily in alkalis, but after a short time will separate out in a state little soluble in alkalis, by the assumption that a physical alteration of the surface energy, as stated by Ostwald in the case of the yellow and red mercury oxides, takes place, though a chemical modification of the state of hydration may have a certain part in those phenomena. A. G.

1388. *Critical Constants of Higher Hydrocarbons.* **P. A. Guye** and **E. Mallet.** (Comptes Rendus, 133. pp. 1287–1290, Dec. 30, 1901, and 134. pp. 168–171, Jan. 20, 1902.)—The authors have determined the critical data for four substances for which the critical temperatures are high, and they take the opportunity to restate the rules which at present establish the complexity of a body for which the critical data are known. The experimental results treated according to these rules show that durene, diphenylmethane, diphenyl, and naphthalene do not exhibit molecular complexity. In the second paper the authors give the critical data for methyl phenyl ether, ether phenyl ether, m-cresol, aniline, dimethyl aniline, dimethylorthotoluidine, and for acetonitrile, propionitrile, butyronitrile, capronitrile, benzonitrile. The results show that the aliphatic nitriles are all polymerised at the critical temperature, and the coefficients of polymerisation are the largest yet obtained for any substance. Even benzonitrile shows some polymerisation. Between the boiling and critical points the nitriles show polymerisation. The remaining substances studied do not show any appreciable polymerisation in the critical state or between the critical and boiling-points. D. H. J.

**1389.** *The System Bismuth Oxide, Nitric Acid and Water.* **G. M. Rutten.** (Zeitschr. Anorg. Chem. 30. 3. pp. 342–406, 1902.)—This is a study of the action of water upon a solution of bismuth oxide in water. The author states that the neutral salt $H^3O(S_{10})$ does not possess any melting-point, as it is decomposed at a temperature of 75·5° into a basic salt and a solution. New salts containing $4H_2O$ and $3H_2O$ respectively and a number of basic salts are found, their composition and crystallic form being analysed. The equilibrium phenomena are next tested, and a number of isotherms and quadruple curves are constructed, by means of which the form of three triple surfaces is determined. From this graphic representation the author draws some conclusions as to the relation between the solubility and formation of the neutral and basic salts, and, on the other hand, the temperature and concentration (in $N_2O_5$) of the solutions. A. G.

**1390.** *Velocity of Chemical Reactions.* **H. Euler.** (Öfvers. Kongl. Vet. Akad. Stockholm, Förh. No. 2. 59. pp. 57–65, Feb. 12, 1902.)—This is mainly a polemical paper directed against R. Wegscheider's criticism [see Abstract No. 896 (1902)] on the author's researches in the theory of catalytical reactions [see Abstracts Nos. 1118 (1900) and 1546 (1901)]. The conclusion of the former that the analogy between the saponification of esthers and the hydrolysis of salts, as assumed by the author, is invalid, is shown to be based on a misunderstanding of principles, and the author's statement that catalysis consists of an increase of those kinds of molecules or ions by whose presence the (non-accelerated) reaction occurs, is shown to be identical with a proposition enunciated by Wegscheider only a few weeks before. The author finally goes on to show that the explanation of catalysis by means of intermediary reactions, which has been cited against the correctness of his views, does not in any way impugn it, the two explanations differing only by their degree of simplicity and generality. A. G.

**1391.** *Instantaneous Chemical Reactions and Ionisation.* **L. Kahlenberg.** (Journ. Phys. Chem. 6. pp. 1–14, Jan., 1902.)—It has generally been assumed that instantaneous reactions between two solutions, giving a precipitate, takes place only between ions, *i.e.*, in electrolytes. The author has tested this view by experimenting with non-electrolytes. The solvent used was carefully purified benzene. The conductivity of this and of the solutions was tested by comparison with that of air, the containing vessel being practically an Arrhenius resistance cell, with a galvanometer in series, the deflection of which was noted first with air and then with the liquid. The most suitable solutes were found to be oleates. The oleates of copper, nickel, and cobalt are readily soluble in benzene and give greenish blue, green and dark red solutions respectively, similar to aqueous solutions. On heating a red solution of cobalt oleate in toluene it turns blue, regaining the dark red colour on cooling. The conductivity was found to be no greater than of pure benzene. There was no action with sodium, nor with magnesium, aluminium, or zinc in copper oleate. The latter appeared to be polymerised according to boiling- and freezing-point tests. There was therefore no indication of ionisation. A solution of dry HCl in benzene was prepared, and was found to conduct no better than benzene itself. This solution does not attack the dry carbonates of sodium, calcium, or barium, nor metallic magnesium. Zinc, however, is acted upon whether amalgamated or not, and platinum in contact with it makes no difference, no hydrogen being evolved from the platinum. An aqueous solution of HCl appears to act rather less readily on zinc than the solution in benzene, and, of course, gives the voltaic effect with platinum. Magnesium, iron, nickel, cobalt, copper, cadmium, mercury, silver, gold and platinum are not attacked, either alone or in contact with other metals. Zinc and aluminium are slightly acted upon, and lead very slightly. Sodium is attacked fairly rapidly. The chlorides are practically insoluble in benzene. When dry HCl gas is passed into a solution of copper oleate in benzene a heavy brown precipitate of cupric chloride is instantly formed, but there is no perceptible increase in the conductivity. The author gives quantitative analyses of the precipitates from copper, nickel and cobalt oleates, the precipitation in each case being complete. Stannic chloride, phosphorus trichloride, arsenic trichloride, and silicon trichloride are miscible with benzene in all proportions, and give solutions which are insulators, but they each precipitate cupric chloride from solutions of copper oleate in benzene. Complete precipitation requires excess of the precipitant as in aqueous solutions. Dry hydrogen sulphide at once throws down sulphides when passed into benzene solutions of the oleates of copper, nickel, and cobalt. In the case of stannic chloride in benzene, sulphide is formed only on standing a considerable time. This is also true of arsenic trichloride in benzene, but sulphides form almost at once if petroleum ether is the solvent. If a solution of dry HCl in benzene is mixed with one of dry ammonia in the same solvent, a precipitate of ammonium chloride is at once formed, although the dry gases will not react. Yet the solutions are non-conductors. Similarly, the HCl solution reacts with a benzene solution of anhydrous pyridine to form pyridine hydrochloride. It therefore follows that instantaneous chemical reactions are not limited to electrolytes, but can take place in solutions which are insulators. W. R. C.

1392. *Cadmium Standard Cells.* **H. Tinsley.** (Electrician, 47. pp. 991–992, Oct. 18, 1901.)—The author has obtained good results, so far as reproduction goes, by using an inverted form of B.T. cell with very little moisture. A discharge curve is given of a rather large cell discharging through 520 ohms. The cell is fairly portable, being made with an amalgamated platinum plate, but the cadmium amalgam is liable to dissociate if the cell is sent by post.

W. R. C.

1393. *Electro-motive Force of Chlorine-Hydrogen Cell.* **E. Müller.** (Zeitschr. Phys. Chem. 40. pp. 158–168, March 25, 1902.)—Numbers varying from 1·31 volts to 1·417 volts are given by different authors as the decomposition-voltage of normal HCl solution; the most usual value is 1·31 volts, which is also taken as the e.m.f. of the hydrogen-chlorine cell when normal HCl solution is used. Smale [Zeitschr. Phys. Chem. 14. 577 (1894)] found different values of this e.m.f. depending on the strength of the

HCl solution. Normal HCl gave 1·360 volts; N/10, 1·472; N/100, 1·547; and N/1000, 1·621 volts. Later, Smale published a correction in which the e.m.f. of the cell, H/1·0 normal HCl/Cl is given as 1·341 volts. A diagram of the author's apparatus, similar to that used by von Wilsmore, is given. The hydrogen and chlorine were each passed through a Richardson's wash-bottle, filled with HCl solution of the same concentration; thence into the electrode tubes, which also were partially filled with acid of the same strength. The electrodes were of platinum sheet and of equal size: the one in contact with the chlorine was polished, and the other platinised; half of each electrode was allowed to dip into the acid. The electrode tubes were connected by side tubes dipping into a dish of HCl. All the acid used was of the same concentration throughout the apparatus, which was kept at a constant temperature of 25° C. in an Ostwald's thermostat. Poggendorff's compensation method was employed to measure the e.m.f., and a capillary electrometer was used. Measurements were made with acid varying from N/1 to N/1000. The e.m.f. found is then compared with that calculated from the formula—

$$E_c = E_0 - (0{\cdot}0002T) \log C,$$

where $E_c$ is the e.m.f. when the ionic concentration is C, and $E_0$ the e.m.f. when it is N/1. Considerable differences were found between the numbers from experiment and from calculation, the difference increasing as the strength of the acid diminished. This is due to the following reaction between chlorine and water—

$$Cl_2 + H_2O \rightleftarrows H + Cl + HClO,$$

which results in an increased concentration of the chlorine ions. The author finds the extent to which this reaction takes place, and applies a correction derived from it to his former results. This has the effect of bringing the experimental and calculated values much more nearly into coincidence. The author finally gives the value 1·3660 volts at 25° C. as the e.m.f. of the chlorine-hydrogen cell with normal HCl; if the dissociation coefficent of normal HCl is taken as 0·78, the e.m.f. of a cell with normal ionic concentration would be 1·3532 volts. The e.m.f. is not altered perceptibly by altering the source from which the chlorine is produced, nor by heating the chlorine before passing it into the apparatus. W. C. B.

1394. *Ionic and Thermal Coefficients of Nitric Acid.* **V. H. Veley** and **J. J. Manley.** (Phil. Mag. 3. pp. 118–122, Jan., 1902.)—From previous measurements [see Abstract No. 1171 (1899)] of the conductivities of nitric acid the authors give a table of the values of $\mu/\mu_\infty$ at 15° for concentrations ranging from 1·3 to 99·97 per cent. The change in the temperature coefficient of conductivity at 96 per cent. strength is ascribed to the formation of the compound $2HNO_3, N_2O_5$. Values of the coefficients of expansion of different concentrations of nitric acid are also given. These values when plotted against percentage composition appear to lie partly on four straight lines and partly on an irregular curve (in the case of the higher concentrations). [See also Abstract No. 124 (1902).] F. G. D.

1395. *Susceptibility of Nickel Amalgams.* **H. Wünsche.** (Ann. d. Physik, 7. 1. pp. 116–141, Dec., 1901. Abstract from the Rostock Dissertation.)—The amalgams were formed by electrolysis of a solution of nickel sulphate, ammonium sulphate and ammonia, with nickel or platinum anode, and a mercury kathode. Iron, which is generally contained as an impurity in nickel or nickel sulphate, is precipitated from the above alkaline solution. Solid amalgams were formed by electrolysis of a solution of nickel sulphate and mercuric chloride. All the amalgams were unstable, the solid more so than the liquid. The former showed globules of mercury on the surface in two hours, and in two or three days were resolved into mercury, nickel, and nickel oxide. When sealed up in an atmosphere of hydrogen they did not decompose, and could be kept for some time under oil. On heating the amalgam decomposes rapidly.

The susceptibility of amalgams with small percentage of nickel was too small to admit of measurement by the magnetometric method. The author therefore had recourse to St. Meyer's method of determining susceptibility by measurement of the attractive force from the formula $\kappa = 2gp/M^2q$ where $p$ is the attractive force in grm., M is the field strength and $q$ is the section of the amalgam in sq. cm. The amalgam was contained in a glass tube 10·5 cm. long, which hung on a Joly balance between the poles of an electromagnet.

The susceptibility increases more rapidly than the percentage of nickel; measured in a field of 8,000 units it is $24{\cdot}9 \times 10^{-6}$ for a 0·5 per cent. amalgam, $121{\cdot}9 \times 10^{-6}$ for a 1 per cent., and $349{\cdot}8 \times 10^{-6}$ for a 3·5 per cent. amalgam, the highest submitted to measurement. The author concludes that the amalgam is a chemical combination and not merely a mechanical mixture.

The 3·5 per cent. amalgam showed the curious property of existing in two different states, one having nearly twice the susceptibility of the other, and being more brittle. The author prepared amalgams of this percentage electrolytically five times under precisely similar conditions; three times the amalgam showed the stronger and twice the weaker magnetism. The higher value found for the susceptibility was $672{\cdot}2 \times 10^{-6}$. This phenomenon did not occur with the amalgams of less percentage, and the author supposes it due to differences in molecular structure. When, however, amalgams of less percentage were formed by diluting this 3·5 per cent. amalgam they gave higher values of the susceptibility than those prepared directly.

Finally the author measured the susceptibility of amalgam when surrounded by solid carbon dioxide at a temperature of −78°, but found no difference in its value. The paper contains curves between the susceptibility and the field strength for amalgams of different percentages. G. H. B.

**1396.** *Persulphates.* **F. M. Perkin.** (Electro-Chemist, 1. pp. 189–190, Aug., 1901.)—An account is given of the discovery and preparation of the persulphates, with a diagram and description of an apparatus for showing their formation. When fairly strong sulphuric acid (50 per cent. to 60 per cent.) is electrolysed, very little oxygen appears at the anode, but the solution shows very strong oxidising properties, due to the formation of persulphuric acid. The ions in the strong acid solution are probably H and $HSO_4$; this assumption is strengthened by the fact that the acid sulphates $MHSO_4$ also yield persulphates, the ions being M and $HSO_4$. The yield of both acid and salts is greatly improved by lowering the temperature; thus at −2° C. the yield was 64 per cent.; at 27° C. 33 per cent.; and at 60° C. 0·9 per cent. (Elbs and Schönherr). Persulphuric acid is unstable in presence of $H_2SO_4$, oxygen being evolved and hydrogen peroxide formed; if the sulphuric acid be removed by adding barium carbonate the solution of persulphuric acid is much more stable. The potassium and ammonium persulphates are the most insoluble of the salts which have yet been prepared, while the barium salt is soluble in water. Manganous salts are oxidised completely to permanganates in presence of a trace of silver salt, whilst with persulphates lead salts yield the peroxide. It has been suggested that this takes place in the production of lead peroxide in storage batteries, but this is regarded as unlikely. A solution of potassium or ammonium persulphate in strong sulphuric acid is a very energetic oxidiser, thus aniline becomes nitroso-benzene, and acetone yields acetone peroxide. From conductivity experiments the persulphates have the formula $MSO_4$; although the ammonium salt has probably the double formula (Bredig). W. C. B.

1397. *Electrolysis of Organic Compounds.* **J. T. Hewitt.** (Electro-Chemist, 1. pp. 34–35, Feb.; 68–69, March; 99–100, April; 120–122, May; 170–172, July; and pp. 218–219, Sept., 1901.)—A series of papers containing a full account of the application of electrolytic methods to organic bodies. It is pointed out that there are two distinct types of organic electrolysis; the first, in which the substance—for instance, the salt of an organic acid—is split up into anion and kathion, and in which the anion generally breaks down into various decomposition products, their nature depending on the concentration; and secondly, production of new substances by oxidation and reduction at the anode and kathode respectively. There are also electrolytic methods applied for the destruction of impurities; for instance, the refining of sugar-juice and the maturing of wines. Electrolysis is also applied in the tanning industry. Electrolytic reduction usually follows the same course as chemical reduction under similar conditions; thus in a solution in strong $H_2SO_4$ nitrobenzene is reduced by zinc to p.-amidophenol, which is also the chief product in the electrolytic reduction of the same solution; again, an alkaline solution of nitrobenzene yields the same products when reduced chemically or by electrolysis. The author divides his paper into parts, dealing firstly with aliphatic and secondly with aromatic bodies, and containing descriptions of processes actually in use, or which promise to be of commercial value. The processes are treated chiefly from the chemical standpoint. In connection with the production of acetylene, besides its use as an illuminant, it is pointed out that it might be converted into hydrocyanic acid by mixing with nitrogen and sparking; also by heating cuprous acetylide with zinc and ammonia ethylene is produced. This is absorbed by strong sulphuric acid giving ethyl sulphuric acid, which, on warming with water, forms alcohol. Iodoform is produced by electrolysis of alcohol in presence of potassium iodide. Chloral also is prepared commercially by electrolysis; this is conducted at a temperature of 100° C. in a still divided into two parts by a diaphragm. The anode is of carbon, and the anode space filled with a concentrated KCl solution; the kathode is copper; alcohol is allowed to flow into the anode space, and is there first oxidised and then chlorinated. The production is 50 grammes of chloral per h.p.-hour. W. C. B.

1398. *Calcium Silicide.* **H. Moissan** and **W. Dilthey.** (Comptes Rendus, 134. pp. 503–507, March 3, 1902.)—On account of the contradictory nature of the published investigations of calcium silicide, the authors have re-examined the body. They prepared it as a grey, friable crystalline mass of metallic appearance (sp. gr. 2·5), by the action of 35 gms. of silicon on an equal weight of lime contained in an electric furnace supplied with a current of 600 amperes at 60 volts. The composition corresponds to the formula $CaSi_2$; calcium silicide, therefore, is analogous to calcium carbide in composition. There is little analogy between the two bodies in chemical reactions; so that water, for instance, which energetically attacks calcium carbide with evolution of acetylene, scarcely reacts with calcium silicide with evolution of hydrogen. D. H. J.

1399. *Recent Developments in the Electro-Metallurgy of Iron and Steel.* **M. Ruthenberg.** (Electro-Chemist, 2. pp. 12–20, March, 1902.)—The first part of this paper deals with the electromagnetic purification and enrichment of inferior magnetic iron ores, containing sulphur and phosphorus. If the sulphur is present as pyrites separation is easy; phyrotite, on the other hand, is more troublesome, having nearly the same magnetic permeability as magnetite. Except in the case of iron phosphide, the elimination of phosphorus is easy. Fineness of grinding is an essential feature in magnetic separation, and the author finds that the best results are obtained by carrying out the process under water. A product containing between 65 and 72 per cent. of iron can thus be obtained. The various methods of briquetting finely divided ore prior to blast-furnace smelting are then discussed. The author's own method consists in passing the cleaned concentrates through an electric furnace, the melting zone of which is a magnetic field. The ore is thus melted, and in doing so loses its magnetism, and gathering weight from new molten material constantly added to it, falls out of the magnetic field. The result is an agglomerated coherent, hard, strong, and porous mass, varying from the size of a bean to that of a walnut, and in a suitable condition for the blast furnace. By mixing powdered carbon with the concentrated ore prior to introducing into the electric furnace, a partially reduced mass results, which, when allowed to drop into a soaking-pit for the proper length of time, undergoes cementation, so that steel is produced; the latter is easily remelted and finished in the open hearth furnace. Thus the direct production of steel without the intervention of the blast furnace may be effected. The author indulges in a comparison between his system and that of the blast furnace. Ferruginous beach sands containing titanium are dealt with, resulting in the almost complete elimination of titanium. He finds that he can melt a ton of iron ore with an expenditure of 500 kw. hours, against 3,000 of previous investigators.

The second part of the paper deals with the reduction of ore by direct contact with a heated surface, and not by an electric arc. Transverse plates of low electrical conductivity are placed in the throat of a conical-shaped furnace, the invention of M. R. Conley, the bottom of which ends in a bulb-shaped hearth. By passing a strong current through the plates, they are heated to incandescence, the ore, which is fed in at the top, being thus fused. The hearth of the furnace is kept hot by a belt electrically heated. In the hearth the ore can be treated just as it would be in an open hearth furnace, and steel instead of pig-iron tapped off. The following is the estimated cost of manufacturing steel ingots directly from iron ore in a Conley furnace of 100 tons a day capacity: 5,000 e.h.p. at 15 dollars per year, per day, 250 dollars; 30 tons of coke at 2 dollars per ton, 60; 200 tons of 65 per cent. ore at 3·5 dollars per ton, 700; renewals per day, 50; labour, 125; making a total cost of 1,185 dollars. The cost per ton of steel ingots at the furnace is 11·85 dollars.

The following is the estimated cost of manufacturing crucible steel in an electrical crucible furnace, of an output of 24 tons per day of 24 hours: Electrical power, 1,250 e.h.p. at 15 dollars per h.p. per year, per day, 62·5 dollars; 12 tons much bar at 28 dollars, 336; 12 tons good pig at 16 dollars, 192; labour, 65; renewals, 25; making a total of 680·5 dollars. The cost per ton of crucible steel at the furnace is 28·36 dollars.

The third part of the paper describes the Harmet process for the production of steel direct from the ore. The furnace has an inclined sole, on to which the ore is fed, the necessary air being forced in under pressure. Additional heat is obtained by an electric current being passed through the pasty mass on the inclined sole. The carbon electrodes can be placed in any position, so as to equalise the distribution of heat in the material. As the molten ore flows down the hearth it meets coke, or anthracite, fed by means of a shaft. A third furnace stores the metal and refines it, so that it can be cast in large quantities. The estimated cost of 1 ton of metal produced is £1 3s. 4d., as against £1 13s. 9d. with the Martin process. O. J. S.

1400. *The Raritan Copper Refining Works, U.S.A.* (Scientific American, 86. p. 187, March 15, 1902.)—This is an illustrated description of the large refinery situated at Perth-Amboy, New Jersey. The copper comes into the works in the form of pigs—testing 95 to 99 per cent. Cu from the western smelters. The furnace-house of the Raritan works contains nine refining furnaces of the usual type, five of these being of 50 tons capacity. It also contains four large furnaces, each of 50 tons capacity, for melting down pig-copper to be used as anodes in the electrolytic vats. The treatment in these furnaces works off some of the impurities, and the resulting anode copper contains in some cases 99½ per cent. Cu. The actual casting of the copper from these furnaces is effected by a casting machine, the anode moulds being carried on a frame which moves on a pivot, under the casting ladle. The anodes cast by the machines are 24 in. × 36 in. × 1 in. in thickness; and are provided with projecting lugs for supporting them in their vats. Twenty-two anodes form a charge for one vat or tank; these weigh between 4 and 5 tons. The tank-house contains 1,600 depositing tanks, arranged in groups of 400 each. The tanks are worked on the multiple system—vats in series, electrodes in parallel. The vats are 2 ft. × 8 ft. × 3 ft. deep, and when charged contain 22 anodes and 23 kathodes. Circulation of the electrolyte is provided for by arranging the vats in sets, each with a well and pump. The thin kathode sheets are formed in 180 "stripping" vats, 36 hours' deposition being requisite to provide a sheet of the desired thickness.

A travelling crane charges the anodes, fixed in a special form of frame, into the vats. The deposition of copper in these vats is allowed to continue seven days, the kathode sheets are then withdrawn and a fresh set are inserted in the vat. The anodes last from 42 to 43 days, before renewal is required. The deposited copper is taken to the 50-ton refining furnaces, and is turned out in any desired form as 99·88 per cent. Cu. The slimes which collect in the vats are boiled in sulphuric acid to extract the copper. The residue is then washed, dried, and smelted on the hearth of a cupel furnace to obtain gold-silver bullion. The separation or "parting" of the precious metals is effected in the usual way. The power-house at the Raritan works contains five vertical cross-compound condensing engines, each direct coupled to a General Electric Company's generator. The size and capacity of these are not given. J. B. C. K.

# STEAM PLANT, GAS AND OIL ENGINES.

## STEAM PLANT.

**1401.** *Flywheels for Slow-speed Engines for Electric Lighting and Traction.* **A. M. Downie.** (Inst. Engin. and Shipbuilders, Trans. 45. pp. 24–38, Nov.; Discussion, pp. 35–67, Dec., 1901.)—The author explains flywheel functions and gives three Figs. of crank effort diagrams with a brief explanation thereof, and the following formula for determining the weight of the flywheel to fulfil certain conditions:—If E be the total energy stored in a flywheel of weight $w$ (supposed to be concentrated at the radius of gyration), when moving with a mean peripheral velocity of $v_0$ ft. per sec; $\Delta_E$ the fluctuation of flywheel energy stored in the flywheel when changing from the minimum velocity $v_1$ through $v_0$ to the maximum $v_2$; $w$ the work done by the engine in one revolution; $q$ the coefficient of speed variation allowable between the maximum and minimum limits; $k$ the coefficient of fluctuation of energy.

$$q = \frac{v_2 - v_1}{v_0} \quad \ldots\ldots\ldots\ldots\ldots(1) \qquad \mathrm{E} = \frac{wv_0^2}{2g} \quad \ldots\ldots\ldots\ldots\ldots(2)$$

$$\Delta_E = \frac{w}{2g}(v_2^2 - v_1^2) = \frac{w}{2g}(v_2 + v_1)(v_2 - v_1);$$

or—

$$\frac{w}{g} \cdot v_0(v_2 - v_1) = 2\mathrm{E}q \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

But—

$$\Delta_E / w = k, \text{ and therefore } k = 2\mathrm{E}q/w.$$

Also—

$$2\mathrm{E} = kw/q, \text{ and } w/g = kw/qv_0^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

The mass of the flywheel is directly proportional to the coefficient of fluctuation of energy and the h.p., and inversely proportional to the coefficient of variation of velocity and the square of the speed. The majority of flywheels are of cast iron with a maximum peripheral velocity of about 100 ft. per sec., or about 80 to 90 ft. per sec. on the mean circumference, the maximum stress due to cent. force being about 1,000 lbs. per sq. in.

For lighting loads, $q$ varies from 1/100 to 1/200.
For lighting alternators in parallel, $q$ varies from 1/200 to 1/300.
For traction, $q$ varies from 1/200 to 1/500.
For traction American practice, $q$ varies from 1/450 to 1/650.

$q$ is sometimes expressed in "Electrical degrees" of variation per impulse:—

Let $p$ = pairs of poles of generator. The number of degrees described by each pair of poles per revolution = 360. The number of degrees described by one engine impulse = $p$ × 360/No. of engine impulses per revolution. If $\phi$ is put for the permissible total variation in degrees then the ratio $\mathrm{S} = \phi \times$ No. of engine impulses per revolution $\times p/360$, which should correspond with $q$ as given above. A common value for $\phi$ is 6°, a 3° increase or lag from the mean. The coefficient of fluctuation of energy is the most important factor in flywheel design, and for this purpose crank-effort diagrams must be constructed. Tables are given with values of *k* and *q*, and fluctuation of crank effort. Actual design and construction are considered. A discussion followed the reading of the paper. J. T. R.

**1402.** *Governing High-speed Engines.* **J. Finkel.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 382–387, March 15, 1902. Paper read before the Westphalian Bezirksvereines, April 10, 1901.)—The author enumerates the causes which limit the speed of trip-valve-gear engines, setting the limit at 90 r.p.m. for Corliss and 125 r.p.m. for drop valves. With positive gears the speed can be much higher. A description of a positive Corliss gear due to Professor Doerpel is given. This gear has expansion valves working in separate chests. The objection is often raised against shaft governors that they give too small an admission and an increased compression when the cut-off is early, the latter point necessitating greater clearance.

Various motions of the eccentric sheave are discussed, and admission, compression, and indicator diagrams are given, including a set which show the effect of governing by (*a*) varying both compression and cut-off, (*b*) throttling only, (*c*) varying cut-off only. Method (*a*) is advocated as the most sensitive and rapid in action. Drawings of several shaft governors are included and a method of varying the tension on the springs to obtain variation of speed is shown. Mathematical theories are not touched upon. R. C. R.

**1403.** *Comparison of Speeds of Two Rotating Axles.* **G. Gauthier.** (Soc. Int. Élect., Bull. 2. pp. 242–244, March, 1902.)—The author describes an optical method of observing (1) synchronism in the speeds of two motors, (2) the increasing or decreasing variation in the ratio of their speeds, (3) the exact value of this ratio when it is such a fraction as $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, &c. The plan adopted is to fix a mirror on the ends of each of the shafts of the two motors (the positions of which must be suitably arranged), the planes of the mirrors being slightly inclined with respect to the perpendicular to the axis of rotation. A ray of light is allowed to fall upon one of the mirrors, whence it is reflected on to the other one and thence upon a screen, where an image is formed dependent on the ratio of the speeds of the motors. If this ratio is unity, the image is a circle; if it attains a value 2, 3, 4, &c., the projected image is epicycloidal, with a number of loops, internal and external, which is equal to the ratio of the speeds. If the ratio is constant, the image on the screen is motionless; if the ratio alters, the image revolves in one direction or the other until when the ratio again becomes constant, it represents the original ratio increased or diminished by unity. The method is easy to apply and capable of great accuracy; if one of the shafts revolves with a known uniform velocity, that of the other can be studied either with respect to its mean value or to cyclical variations. [See Abstracts Nos. 940 to 945 (1902).] B. P. S.

**1404.** *Distortion in Boilers Due to Overheating.* **C. E. Stromeyer.** (Engineering, 73. pp. 458–460; Discussion, pp. 434–435, April 4, 1902. Paper read before the Institution of Naval Architects.)—From Professor A. Ledebur's investigation and the author's estimate of the results of A. F. Yarrow's boiler experiments, 4,000° F. is assumed as the maximum furnace temperature obtainable in boilers. Under the action of this temperature the upper half of a cylindrical furnace would expand more than the lower, the total resulting deformation being a difference between horizontal and vertical diameters of about 2 in. The stresses produced in a water-tube boiler surrounded by that temperature are calculated on the assumption that they are the same as are set up in a plate which is being bulged to a radius of 550 in. calculated by $S_1 = Et(\mu^2 - 1)(\mu + 1/2\rho\mu^3$, where $E =$ modulus of elasticity $= 30{,}000{,}000$ lbs. per sq. in.; $t =$ thickness of plate in inches; $\rho =$ radius of curvature in inches; $1 : \mu =$ coefficient of cross contraction. $S_1$, therefore, equals 40,000 lbs. per sq. in. $\times\, t = 17{\cdot}8$ tons per sq. in. $\times\, t$. The stresses are due to the temperature gradient in the metal and depend on the thickness. If 10,000 lbs. per sq. in. be the maximum permissible strength for a water-tube exposed to internal pressure, $P = 200$ lbs. with a fire of maximum intensity, the limiting diameter is found as follows: 10,000 lbs. per sq. in. $= S = S_1 + S_2 =$ the sum of stresses, $S_1 = 40{,}000\,.\,t$; $S_2 = PD/2t = 200\,D/2t = 100\,D/t$; $10{,}000 = 40{,}000\,.\,t + 100\,D/t$; $D = 100\,.\,t - 400\,.\,t^2$ and $dD/dt = 0 = 100 - 800\,t$. It results that for lesser thicknesses than $\frac{1}{8}$ in. the tube diameter must be smaller than 6·4 in., for greater thicknesses the diameter must be reduced. The heating surfaces are taken as clean in these cases. The remainder of the paper is devoted to considering the effects of the addition of $\frac{1}{10}$ in. thickness of scale, and of $\frac{1}{100}$ in. thickness of grease upon the water side of the boiler surfaces, on the basis of E. M. Bryant's determination of the temperature gradient in transmitting heat through boiler-plates. In transmitting enough heat through 1 sq. ft. to evaporate 20 lbs. water per hour, the temperature gradient will be 40° F. per inch of thickness. In a layer of scale the gradient must be 100 times greater or 4,000° F. difference on either side of a thickness of 1 in., and therefore 400° F. for $\frac{1}{10}$ in. If 140 evaporative units of heat per hour be transmitted the mean temperature of a clean furnace-plate will be 70° F. higher than that of the water. With scale added these temperatures become 410° F., with 20 lbs. evaporation, and 2,870° F. with 140 lbs. evaporation with corresponding increase of stresses. The action of scale and of grease in causing bulging of furnace-flues and water-tubes is then discussed, that of grease being considered in view of various theories of the action which causes the collapse of furnaces, but without any finally satisfactory result being reached. This part of the paper contains, however, much suggestive information as to the time required to overheat metal plates, water hammer in boilers, retarded ebullition, &c.

F. J. R.

**1405.** *The Automobile and Specialty Co.'s Flash Boiler.* (Automobile Rev. 6. pp. 49–50, March, 1902.)—The boiler is built up of a number of sections which are connected together side by side. Eight of these are employed for a light car of the runabout type. The sections are made of a special steel, having a tensile strength of 70,000 lbs. per sq. in. They resemble hollow drums, 9 in. in diameter and 3 in. across, and are provided externally with vertical ribs which increase their heating surface. Central openings in each end serve to connect them in series with one another and to connect the boiler both with the water feed and with the steam supply pipe. Steel discs are provided inside the sections; these are centrally placed and are half an inch smaller in diameter than the cavities in the drums. The discs compel the water and steam to pass over a greater surface in the generator, and the space between the disc and the section itself is filled with small particles of copper. The sections are connected together by heavy nipples and the boiler is placed horizontally over the heating burner. An automatic feed-water system is used. A pump driven by the engine delivers water from the supply tank into a closed seamless drawn steel tank, communicating with the one end of the boiler. This latter tank, which is fitted with a pressure gauge, contains air acting as a compressible cushion. The water is free to flow to the generator or to return from it to the tank; the feed to the boiler therefore depends upon the relative pressure in the tank and in the boiler. The pressure in the tank is kept constant by the combined action of the pump and of a relief valve in its delivery pipe; the relief valve opens when the pressure rises abnormally, and it returns the surplus water to the supply tank. The fuel feed to the burner is also automatic. The fuel is taken to the burner through a specially constructed copper plug, which is screwed into one section of the boiler. The plug is so arranged that it produces an excess of gas if it is overheated, and the gas thus formed is said to retard the flow of fuel to the plug, reducing the fire. A. G. N.

**1406.** *Superheated Steam in Engines.* **R. Lenke.** (Inst. Mech. Engin., Proc. 4. pp. 847–853; Discussion, pp. 854–864, Sept., 1901. Paper read before the Glasgow Engineering Congress (Section III), 1901.)—The behaviour of superheated steam is similar to that of gases. The thermal capacity of steam is 0·48, therefore little heat is required to superheat it. The heat radiation loss due to working with superheated steam is less than that with saturated steam owing to the lower calorific value of superheat as compared with the latent heat of saturated steam. Superheat increases the volume per unit of weight as shown by Table I.:—

TABLE I.

| Pressure. | 390° F. | 570° F. | 750° F. |
|---|---|---|---|
| 70 | 1·1 | 1·33 | 1·57 |
| 115 | 1·06 | 1·29 | 1·52 |
| 170 | 1·02 | 1·24 | 1·46 |

Owing to increase in volume, superheated steam requires less B.T.U. to produce a given volume than saturated steam at the same pressure. Table II. gives total heat per cubic foot for various pressures:—

TABLE II.

| Pressure. | Saturated. | 390° F. | 570° F. | 750° F. |
|---|---|---|---|---|
| 70 | 233 | 219 | 192 | 175 |
| 115 | 350 | 337 | 297 | 267 |
| 170 | 492 | 485 | 432 | 398 |

For example, to produce 1 cub. ft. at 115 lbs. and a temperature of 570° F. $(350 - 297)/350 = 15$ per cent. less heat is required than to produce 1 cub. ft. of saturated steam at the same pressure. To obtain full economical benefit the highest temperature safe for superheater and engine is 660° to 700° F., but engines must be specially designed to stand this temperature. The author mentions various parts of engines likely to give trouble with superheat. J. T. R.

**1407.** *Use of Superheated Steam in Semi-portable Engines.* (Génie Civil, 40. pp. 364–366, March 29, 1902.)—This article describes and illustrates a semi-portable compound engine and boiler, on R. Wolf's system, with superheater attached to the boiler. The superheater is composed of a long length of tube bent into a number of spirals placed on edge one after the other in the path of the hot gases, in a space between the horizontal flame-tubes and the chimney. The ordinary fire-tubes are made shorter than usual, and the first portion of the superheater is within a chamber which is surrounded with the water of the boiler as is the furnace which is formed of a Purves or Morison tube. Steam enters the superheater coils at the chimney end, passes through them in series, and is taken from the coil nearest the tube-plate by a straight tube passing along the space in the centre of the coils to the front end of the casing from which it is led to the engine. The engine cylinders are placed in the steam dome. Tests carried out by Lewicki, Professor at the Ecole Polytechnique of Dresden, in April, 1901, gave the following results :—

| | | |
|---|---|---|
| Heating surface of the boiler in contact with water ... | 31 | sq. m. |
| „ „ superheater „ hot gases | 20 | „ |
| Grate surface ........................................ | 0·85 | „ |
| Diameter of high-pressure cylinder ..................... | $0·240\frac{1}{10}$ | m. |
| „ low „ „ ..................... | $0·450\frac{8}{10}$ | „ |
| Length of stroke ........................................ | 0·480 | „ |

The boiler pressure was about 160 lbs. per sq. in. (12 kg. per sq. m.), the speed of the engine 170 r.p.m., and the effective power 100 b.h.p. In the trials about 108·5 b.h.p. and 118·5 i.h.p. were obtained—the mechanical efficiency being 91·6 per cent. The feed-water was supplied at 35° C., and the saturated and superheated steam were respectively 190·57° and 329·60° C. The mean superheat was 139·03° C. The temperature of the gases at entrance of flue was 215° C. The coal from analysis showed a calorific value of 7,910 calories. The consumption of this coal was 0·648 kg. per e.h.p. Quantity of heat utilised per sq. m. of heating surface of boiler reached 11,662 calories, and per sq. m. of superheater 1916·5 calories. Under these conditions the consumption of steam per i.h.p.-hour was 4·85 kg., and per b.h.p. 5·293 kg.—the calorific efficiency being thus 18·9 per cent. per i.h.p., and 17·3 per cent. per b.h.p. F. J. R.

**1408.** *Construction and Operation of Cooling Towers.* **J. R. Bibbins.** (Eng. News, 47. pp. 223–226, March 20, 1902.)—The author discusses the improvement in distribution of surface provided in cooling towers, as illustrated in two early forms and in the Worthington tower and an experimental tower built for the Edison Illuminating Company, of Detroit, Mich. The efficiency of the tower depends upon the effectiveness of the cooling surface, as it has been found that the reduction of temperature is almost entirely due to evaporation and not to conduction. The Worthington tower employs tile or galvanised iron tubes of about 2 ft. in length set on end in tiers with sheets of wire netting between the tiers. A stand-pipe in the centre rises above the tubes into the upper air chamber, where it distributes the water in spray from perforated tube arms. In the tower at the Edison Company's Works the cooling surface is entirely constructed of "mats" or grids of timber laths assembled on a substantial backing strip with short separator pieces between the laths. The successive tiers are placed at different angles so as to prevent the water falling freely without passing over the rough surface of the grids. The water is distributed by perforated tubes branching from the stand-pipe at the top. Records of some tests with this tower are given, and also diagrams with plotted curves to show the relations of the different results to one another and to calculated results. F. J. R.

**1409.** *Kennicott Water Softener.* (Railroad Gazette, 34. p. 181, March 14, 1902.)—As installed on the Union Pacific Railroad, this apparatus has a capacity of 150,000 gallons per day, and consists of a settling tank, which is a steel cylinder 43 ft. high and 13 ft. in diameter, alongside of which is a lime-water tank 25 ft. long and 8 ft. diameter. The water comes from two artesian wells about 1,000 ft. deep, and is led to the softener through a 6-in. supply pipe. The treated water is drawn off into two 50,000-gallon storage tanks placed about 400 ft. apart. The following analysis shows the water before and after treatment:—

| | Grains per gallon. | |
|---|---|---|
| | Before treatment. | After treatment. |
| Silicia | 0·79 | 0·40 |
| Carbonate of Lime | 9·86 | 3·45 |
| Carbonate of Magnesia | 3·51 | 0·20 |
| Sulphate of Magnesia | 7·03 | None |
| Carbonate of Soda | 1·12 | 0·29 |
| Sulphate of Soda | 4·70 | 7·80 |
| Chloride of Soda | 16·48 | 14·49 |
| Total Solids | 43·49 | 26·63 |
| Incrusting Solids | 21·19 | 4·05 |

The steel settling tank has a conical bottom, and from the point where the water enters above there is an inner cone-shaped partition, the diameter increasing downwards. The water flows downwards inside the cone, and ascends between the conical partition and the outer shell to the soft water overflow. This increases the cross-section and gradually diminishes the rate of flow in both directions favouring the deposition of solids. The cone also serves as an oil trap when condensing water is used. Floats and valves regulate the process automatically. For treating 150,000 gallons in 24 hours, 57 lbs. soda ash and 1½ barrels of lime are required on the Union Pacific.

F. J. R.

## GAS AND OIL ENGINES.

**1410.** *Ignition Device for Automobiles.* (Motorwagen, 5. pp. 82–83, March 15, 1902.)—A description is here given of an electromagnetically controlled spark ignition contrivance invented by Herr Hellmann of the Dürr Motor Co. In this device, which is intended to overcome the disadvantages of the mechanical driving connections required with ignition arrangements of the Simons-Bosch magneto type, the "extra" current spark arising on breaking an inductive circuit is utilised for effecting ignition, and for this purpose a circuit is provided containing a battery, and a bell electromagnet which is arranged on the outside of the motor cylinder. The electromagnet actuates a spring-controlled armature, the pivot of which passes through the cylinder end and has attached to it a contact blade forming one of the terminals of the circuit and normally held in engagement with an insulated stud which forms the other terminal. The circuit is made and broken alternately between the stud and movable blade, and the spark which passes at break due to the attraction of the armature by the electromagnet, causes ignition of the explosive charge. By adjustment of the spring the interruption of the circuit is caused to take place when the current has reached its maximum value, so that a very intense self-induction spark results. J. G.

**1411.** *Moorwood Bennett Carburettor.* (Automotor Journal, 6. pp. 155–156, Jan., 1902.)—This carburettor for heavy oil engines consists of three concentric metal cylinders, of which the inner cylinder is an air inlet tube, the middle cylinder is the kerosene reservoir, and the outer cylinder forms a jacket for heating the oil by means of the exhaust from the engine. At the lower end of the inner cylinder is an adjustable valve, by means of which the admission of kerosene is regulated. The air, carburetted by passing through the heated kerosene, escapes through holes at the top of the kerosene container into the upper part of the jacket cylinder, and passes thence to the engine cylinder. The upper part of the jacket is separated from the portion through which the exhaust passes, by means of a flange projecting from the middle cylinder. On starting the engine, the apparatus is heated by an external burner. It has been successfully used on a 9-b.h.p. Crossley gas engine converted into an oil engine ; at the Sheffield Technical School the engine gave 14 b.h.p. when fitted with the oil carburettor. C. R. D'E.

## AUTOMOBILISM.[1]

**1412.** *Mechanical Traction and Electric Lighting in Warfare.* **F. Otto.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 349–350, March 8, 1902.)—The author advocates in this article the use of traction engines instead of the ordinary horse traction as a better means for quick motion and as more economical. Admitting that to each traction engine are attached five cars, the number of horses dispensed with is 21, and instead of the 10 riders and one officer usually required only four people would have to be employed, viz., two engineers and two stokers. The author suggests that the steam engine is better than gas or oil motors for the purpose, because the necessary fuel could easily be obtained everywhere, whereas in using gas, oil, or benzine motors very large quantities of fuel would have to be carried. The author thinks that if the speed attained exceeds 5 km. per hour on ordinary roads, or 10 km. on level roads, the purpose is well served. A traction engine capable of developing about 20 or 30 h.p., and of a total weight not exceeding 9 tons, would be a suitable one. The author emphasises the great advantages derived from the electric light in the battlefields for the many purposes for which it can be used, and suggests that the traction engine should be so constructed that the power generated should be utilised also for the working of cranes, pumps, or independent dynamos, which should not be placed on the same truck, but should be fixed to independent cars, and coupled to high-speed engines or steam turbines. The necessary steam for these engines or steam turbines should be taken through separate pipes from the boiler of the traction engine. In the event of more light being required occasionally, several cars carrying dynamos should be added. The generated electric power could also be used for driving electric motors for bread-kneading and other mechanical purposes. The author shows that by adopting that system of haulage, for instance, in Germany, by introducing only 500 such traction engines, the number of horses to be dispensed with would be about 10,000, and a reduction of over 8,500 persons, as only 1,000 mechanicians and 1,000 stokers would be sufficient to do the work. In distributing these traction engines all over the country, and making use of them all the year round, either for haulage or lighting the barracks or camps, &c., or for driving machinery, the expenses incurred in their purchase would be a good investment. L. G.

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[1] Electric Automobiles are described in the Section dealing with Electric Traction.

**1413.** *Overman Steam Car.* (Scientific American, 86. p. 139, March 1, 1902.)—This is a light two-seated vehicle, built on the lines now common to American vehicles of this class, but with various modifications in details. The mechanism is as far as is possible enclosed. An automatic feed-regulator controlled by a thermostat is employed, the feed-pump being driven at a comparatively slow speed from the rear axle ; the stroke of the pump plunger is adjustable. The feed-water is heated by passing through a coil of tubing in an exhaust steam-jacket. An injector is also fitted. Air pressure in the fuel tank is maintained by a steam operated pump under control of the driver. This pump is also automatically controlled by a pressure diaphragm which brings the pump into action if the pressure in the fuel tank falls 4 lbs. below the normal. The boiler is fitted with a fusible plug, the melting of which causes a valve controlling the gasoline supply to close. The boiler is of the vertical fire-tube type, and the engine a two-cylinder vertical, with cylinders 2·5 in. bore × 3 in. stroke. Transmission is by a single-chain gear to the live rear axle. C. R. D'E.

**1414.** *Schaudel Carriage.* (Locomotion Automobile, 9. pp. 198–201, March 27, 1902.)—In this car a double-cylinder horizontal engine and a three-speed spur change gear are combined to form a single piece of mechanism, the change-gear being enclosed in an extension of the crank chamber. The flywheel is mounted externally to the crank chamber, at one end of the crank-shaft, and the female portion of the cone clutch, at its opposite end, outside the gear-enclosing extension chamber. The male portion of the clutch runs free on the extremity of the crank-shaft when the clutch is out of engagement. The motor is mounted in the car with the crank-shaft at right angles to the length of the frame, and the transmission to the live rear axle is effected by a single-chain drive at one side, external to the frame, the chain pinion being mounted on the male portion of the friction-clutch. Several illustrations of the mechanism are given. [See also Abstract No. 947 (1901).] C. R. D'E.

**1415.** *Duryea Gasoline Carriage.* (Scientific American, 86. p. 147, March 1, 1902.)—This is a light three-wheeled carriage, the rear wheels being drivers, and the front wheel used for steering. It is propelled by a three-cylinder horizontal engine mounted below the seat of the body. Transmission is effected by an epicyclic gear giving two speeds forward and one reverse, and a final chain drive to the exterior of the differential gear on the live rear axle. The cylinders are 4·5 in. bore × 4·5 in. stroke, and the engine is sufficiently powerful to propel the car on the highest gear under all ordinary conditions. The engine is throttle controlled by varying the lift of the inlet valves. [See Abstract No. 1185 (1902).] Low-tension electric ignition with a magneto machine is employed. C. R. D'E.

**1416.** *Consumption Trials of Motor Carriages.* (Génie Civil, 40. pp. 849–850, March 22, 1902.)—Tables of results of several recent consumption trials held in France are given. Table I. contains the results obtained in the French Automobile Club trials of petrol cars during the Paris Exhibition of 1900:—

TABLE I.

| | | Total weight loaded. | Total Consumption. | | Consumption per tonne km. | |
|---|---|---|---|---|---|---|
| | | | 800 km. of road. | 34·35 km. of level track. | Road. | Track. |
| | | kilogr. | litres. | litres. | litres. | litres. |
| Voiturettes | Gladiator ......... | 400 | 48·500 | 2·250 | 0·129 | 0·150 |
| | de Dion-Bouton | 560 | 64·000 | 3·090 | 0·139 | 0·158 |
| | Renault Frères | 490 | 66·000 | 2·750 | 0·172 | 0·159 |
| Voiturettes—weight fr. 400 to 1,000 kg. | Peugeot............ | 750 | 56·680 pr.687 km. | 3·100 | 0·110 | 0·120 |
| | Delahaye ......... | 689 | 55·900 pr.682 km. | 2·850 | 0·120 | 0·122 |
| Light cars—weight fr. 1,000–to 1,500 kg. | Delahaye ......... | 1,320 | 64·750 pr.68[illegible] km. | 3·680 | 0·072 | 0 081 |
| | Gobron-Brillié... | 1,230 | 73·000 pr.619 km. | 5 000 | 0·095 | 0·118 |
| | Rochet-Petit ... | 1,000 | 71·000 pr.690 km. | 3·000 | 0·102 | 0·687 |
| Carriages—weight fr. 1,500 to 2,000 kg. | Delahaye ......... | 1,420 | 97·000 pr.697 km. | 4·000 | 0·077 | 0·080 |
| | Brouhot............ | 1,760 | 142·000 pr.687 km. | 5·000 | 0·117 | 0·080 |
| Carriages—weight more than 2,000 kg. | Panhard-Levassor | 4,310 | 241·500 pr.697 km. | 3·900 pr. 11 km. | 0·081 | 0·078 |

Table II. gives the best results for the "*Criterium de l'alcool,*" of October 28, 1900, organised by the "Vélo" from Paris to Rouen, 127 km.

TABLE II.

| | | Total weight loaded. | Consumption 50 per cent. Alcohol. | |
|---|---|---|---|---|
| | | | For 127 km. | Per tonne km. |
| | | kilogr. | litres. | litres. |
| Light cars | Darracq .............................. | 540 | 8·500 | 0·123 |
| | Clément-Panhard .................... | 567 | 9·000 | 0·124 |
| Carriages | Gobron-Brillié ...................... | 1,279 | 15·000 | 0·092 |
| | De Diétrich ......................... | 1,540 | 19·400 | 0·099 |
| | Panhard-Levassor ................ | 1,280 | 17·000 | 0·104 |

Table III. gives the best results for the "*Course Paris Roubaise*," April 7–8, 1901, 278·64 km.

TABLE III.

| | | Total weight loaded. | Consumption 50 per cent. Alcohol. | |
|---|---|---|---|---|
| | | | For 278·64 km. | Per tonne km. |
| | | kilogr. | litres. | litres. |
| Voiturettes | Darracq | 570 | 18·000 | 0·1120 |
| Light cars | Gillet-Forest | 725 | 22·850 | 0·1120 |
| | Darracq | 725 | 23·300 | 0·1140 |
| Carriages | Société Nancéenne | 1,325 | 33·000 | 0·0890 |
| | Panhard-Levassor | 1,550 | 39·450 | 0·0909 |
| | Delahaye | 925 | 24·000 | 0·0920 |
| | Delahaye | 1,240 | 34·000 | 0·0979 |
| | Martha-Bollée | 1,535 | 42·500 | 0·0988 |

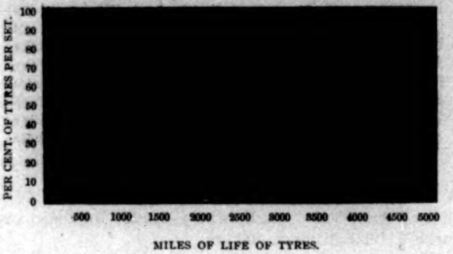
Table IV. gives the best results for the "*Criterium de Consommation*," organised by the "Auto Vélo" on February 5, 1902, and also over the same course on March 5, 1902, distance 100 km.

TABLE IV.

| | | Poids Total. | Liquide Employé le 5 mars et sa densité à 9° | Consommations du 5 Mars. | | | Consommations du 5 févr. à la tonne kilomètres. |
|---|---|---|---|---|---|---|---|
| | | | | totale pour 100 km. | à la tonne-kilomètre. | | |
| | | kilogr. | | litres. | litres. | kilogr. | litres. |
| Voiturettes | Peugeot | 550 | Essence à 690 | 4,890 | 0,0889 | 0,0613 | 0,1050 |
| | Peugeot | 550 | Id. | 4,900 | 0.0891 | 0,0614 | 0,1060 |
| | G. Richard | 510 | Essence à 712 | 5,580 | 0,1090 | 0,0776 | 0,1140 |
| Voitures légères ... | Darracq | 750 | Essence à 716 | 4,850 | 0,0646 | 0,0462 | 0,0876 |
| | De Dion Bouton | 865 | Essence à 690 | 6,330 | 0,0731 | 0,0504 | 0,0894 |
| | Korn | 733 | Id. | 5,500 | 0,0750 | 0,0517 | 0,0911 |
| | G. Richard | 600 | *Alcool à 50%* | 4,985 | 0,0830 | „ | 0,1027 |
| | Peugeot | 1060 | Essence à 500 | 8,890 | 0,0838 | 0,0586 | 0,0888 |
| Voitures ... | Chenard et Walker | 1070 | Essence à 714 | 5,500 | 0,0514 | 0,0367 | 0,0599 |
| | Bardon | 918 | Essence à 705 | 6,470 | 0,0704 | 0,0496 | 0,0857 |
| Grosses voitures | Delahaye | 2060 | Essence à 690 | 15,130 | 0,0734 | 0,0506 | 0,0943 |
| | G. Richard | 1240 | Essence à 680 | 10,000 | 0,0806 | 0,0548 | 0,1085 |
| | Delahaye | 1240 | Essence à 690 | 10,650<br>(pour 60 km.) | 0,0858 | 0,0592 | 0,1076 |
| Véhicules industriels | De Diétrieh | 2890 | Essence à 698 | 12,900 | 0,0744 | 0,0519 | 0,0709 |
| | Gillet-Forest | 1838 | Essence à 716 | 13,290 | 0,1208 | 0,0865 | 0,0966 |

The most striking results obtained on the 5th of March being the consumption 0·0514 litres per tonne kilometre for the Chenard & Walker car, and 0·0646 litres for the Darracq light car [see Abstract No. 555 (1901)]. The Chenard-Walker car ran on a mixture of petrol and petroleum sp. gr. 0·714, and the Darracq on petrol of sp. gr. 0·716 + a solution of picric acid dissolved in alcohol. C. R. D'E.

**1417.** *Tyres for Heavy Vehicles.* **A. L. Stevens.** (Horseless Age, 9. pp. 163–166, Feb. 5, 1902.)—During an extensive experience with pneumatic and solid rubber tyres, the accompanying curves have been plotted from the results obtained with five sets of tyres destroyed on the streets of New York. The tyres were all used on vehicles averaging a little over 2 tons. The curves show the distance after which a given percentage of each set was destroyed. Curve (I) is for a set of 106 5-in. pneumatics (single tube) fixed to the rims by screwed lug bolts. The average cost of these tyres is 12·5 cents per ton mile. Curve (II) is from a set of wired-on solid rubber tyres. These all tore out from their fastenings, and cost 10 cents per vehicle mile. Curve (III) is from a set of 41 5-in. pneumatics of better quality than set (I), also fixed by screwed lugs. The cost is about 12 cents per vehicle mile. Curve (IV) is from a set of specially heavy walled pneumatics, having small air space and internal layers of sponge rubber. The cost with these was excessive. Curve (V) is from a set of 197 tyres of the same make as set (I), but fixed by projecting pins having freedom to move readily, instead of by fixed bolts; they cost about 7·75 cents per vehicle mile. During these tests it was clearly established that economy in running was secured by increasing the air pressure in pneumatics from 80 to 125 lbs. per sq. in. The author has used a solid tyre built up of layers of fabric edgewise to the road surface, bedded in a rubber matrix, and vulcanised under pressure, with notable success. C. R. D'E.



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**1418.** *Silent Chain Gear.* **J. O. Nixon.** (Amer. Soc. Mech. Engin., Trans. 23. No. 929. pp. 373–383; Discussion, pp. 383–386, Dec., 1901.)—A description of the chain gear developed by H. Renold, of Manchester, with instances of its application for high-speed driving. H. R. C.

**1419.** *Modern Practice in Boiler-making Shops.* **E. P. Watson.** (Eng. Mag. 3. pp. 19–44, April, 1902.)

**1420.** *Waste Heat Engines.* **G. H. Barrus.** (Cassier, 21. pp. 503–507, April, 1902.)

**1421.** *A Regenerative Accumulator and its Application for using Exhaust Steam.* **A. Rateau.** (Inst. Mech. Engin., Proc. 4. pp. 945–948; Discussion, pp. 954–958, Sept., 1901. Paper read before the Glasgow Engineering Congress (Section III), 1901.) J. T. R.

## GENERAL ELECTRICAL ENGINEERING.

**1422.** *American Meter Practice.* **L. C. Reed.** (Amer. Electn. **14.** pp. 144–147, March, 1902.)—The author describes in this article the methods used for the measuring of power in alternating-current circuits. The non-inductive meter can be used for either direct or alternating current [see Abstract No. 1561 (1899)]. The induction form of meter used is explained in detail and its application described. The author takes some typical cases of single, two, and three-phase circuits, and indicates by way of diagrams the necessary connections which have to be made in order to measure the true watts. The power in a three-phase circuit may be measured by one, two, or three wattmeters or their equivalent of either the inductive or non-inductive type. For balanced three-phase loads one meter is sufficiently accurate, but when load becomes unbalanced two legs of the circuit must be metered. The case where only one meter is used to measure unbalanced polyphase power-factors is confined to meters of the inductive type, where one or more measuring elements are combined to give a resultant measuring value to a common movable armature. The author describes also the measuring of power on monocyclic systems, in which a regular single-phase circuit is used in conjunction with a third wire called the "teaser," which differs from the single-phase circuit by 90° in phase. In the generator one end of the teaser coil is tapped on to the middle of the single-phase coil, and the other end leads to a collecting ring. That system is adapted to the distribution of light and power, the lights being connected to the single-phase in the usual way. The primaries of the two transformers are placed in series, with the teaser connected to their junction. The secondaries are cross connected, forming a resultant lop-sided three-phase relation, which is used to operate a three-phase motor in the same manner that a regular three-phase system would do. To meter the power passing in the circuit, in using non-inductive meters, one is connected in each outside leg, and the potential circuit is connected between the given leg and the common return. With inductive meters, the regular polyphase meter used for three-phase and two-phase systems is placed in the circuit. The paper is fully illustrated. L. G.

**1423.** *Correction Coils for Wattmeters.* **R. Beattie.** (Electrician, **48.** pp. 818–819, March 14, 1902.)—When the lag in the pressure circuit of a wattmeter is small, the actual reading is $D\,(1 + \frac{Lp}{R}\tan\theta)$, where $Lp$ and $R$ are the reactance and resistance of the pressure circuit respectively, and $D$ is the true reading. The actual reading then is a linear function of $L$, and if readings were taken with two different values of $L$, and the line joining them produced to cut the ordinate at $L = 0$, the value of this ordinate would be the true reading. The author proposes to make use of this principle by providing the wattmeter with a coil of inductance equal to that of the fine-wire circuit, and arranging a two-way switch to put in the circuit either this coil or a non-inductive coil of equal resistance. The error in the reading will then be doubled by introducing the inductive coil into the circuit, and so can be readily measured. The author shows that the accuracy of this method is independent of the wave-form. G. H. B.

**1424.** *Reports on the Visit of the I.E.E. to Germany in* 1901. (Inst. Elect. Engin., Journ. 31. pp. 534–548; Discussion, pp. 549–578, March, 1902.)—The first report is that of the Committee on Traction, Light, and Power Distribution. In German stations, engines are commonly of the horizontal slow-speed type, running at from 80 to 100 r.p.m. In some cases vertical engines are used; but they are considered to cost more in attendance, and to be higher in prime cost. The enclosed high-speed engine is not used. Water-tube boilers are almost universal, and superheating up to 50° C. is very common, this being effected generally by separately fired superheaters. The bulk of the new work is on the three-phase system. In Berlin, continuous current is distributed; but large stations, containing 90,000 h.p. in three-phase plant, have been built in the suburbs, whence the power is transmitted to central points for distribution and transformation. Very little single-phase or bi-phase work is being done. Inductor alternators are practically extinct. Mention is also made of direct-coupled slow-speed pumping plants. [See also Abstract No. 596 (1902).] The periodicity used is almost always 50; rotaries up to 800 kw. are run at this periodicity in substations in Berlin. The Allgemeine Elektricitäts Gesellschaft used direct-current motors in their old works; but in their newer factories they use three-phase motors throughout, except for driving the cranes in one building, this being done by direct current supplied from motor-generators, which also supply current for inverted arc lighting. At Lahmeyer's works polyphase motors are used for driving groups of machines, while single machines are driven by continuous-current motors. Accumulators are used on a large scale, and amount sometimes to 20 or 25 per cent. of the whole of the plant. An uninsulated middle wire is used on a three-wire system. On tramways, the sliding bow appears to be extending faster than the trolley; it gives a simpler overhead construction at curves and junctions, and more latitude in the position of the overhead wire. The sliding of the bow gives quieter running. The next report is from the Committee on Manufacturing. Small induction motors have short-circuited rotors, and wire resistances in the stator; large motors are started by liquid resistances, usually in the rotor circuit. These resistances consist of lead plates dipping into iron vessels containing a solution of soda. On switchboards high-tension switches are usually fixed behind the board, and worked by insulated levers which are brought through to the front. Very long breaks are allowed, viz., from 10 to 15 in. for 3,000 volts, and 20 to 30 in. for 10,000 volts. Various other details in connection with switchboards and machinery generally are mentioned. Figures are also given relating to the wages paid in Germany. The last report refers to Telephones, and is mainly concerned with a statement of the rates charged in Berlin and the suburbs. The charge for communication in Berlin and the immediate suburbs is £9 a year. In the discussion, **A. Siemens** stated that accumulator traction had proved a failure in Hanover, and that it was now proposed to use the trolley system throughout. On the high-speed experimental railway at Zossen, the speeds had been increased very gradually, and one of 95 miles an hour had now been reached. The experiments about air resistance, which had been made beforehand, had been amply confirmed in actual running. **G. Hooghwinkel** said that an uninsulated middle wire was almost universally used on distributing systems in Germany; the middle wire has usually a sectional area of 25 per cent. of that of the outers. The allowable loss of volts in the middle wire should never exceed 3 volts in any case; and this pressure can cause no danger to gas-pipes. He also contended that with this system the existence of faults was more easily discovered, and the insulation resistance of the system could be kept up to a higher standard. **M. O'Gorman** drew attention to the elaborate precautions which are taken in German cable works with a view to securing cleanliness. The most important particular in which the Germans are ahead of us in the manufacture of cables is the adoption of the vacuum drying and vacuum impregnating tanks. By means of large cast-iron chambers, which are steam-heated, all free moisture is removed from cellulose without exceeding a temperature of 220° F., and without producing any of the partial decomposition of the cellulose, accompanied by the evolution of water, which is brought about by heating for a lengthened period at 240° F. High-tension cables are completely dried on the vacuum system in about 10 hours. Several of the cable works stock only one size of copper wire, and draw it down themselves to suit their requirements. This tends to reduce the amount of capital locked up in copper wire. W. H. S.

**1425.** *Locating Metals by Electricity.* (West. Electn. 29. pp. 317–318, Nov. 16, 1901.)—Describes a method of locating metallic veins underground which consists in carrying an overground wire across the land to be surveyed, in a series of parallel lines. At the end of each line contacts are inserted, and the resistance between them is measured. It is stated that the fall of resistance, when near a metallic vein running between the contacts, is so great that no difficulty is found in locating a metallic vein. It is stated that an average resistance of 54,000 ohms fell in a particular case to 56 ohms when over a rich copper vein. Other instances are given. LL. B. A.

**1426.** *Efficiencies of Electric Cranes.* **R. Matthews.** (Mech. Eng. 9. pp. 348–350, March 15, 1902. Paper read before the Manchester Association of Engineers.)—This paper gives several tables showing the results of tests made on cranes of various powers in operation at Armstrong's works. These tests were carried out under ordinary working conditions, and the figures are the results of a number of trials for each load. Figures relating to the size and construction of the different cranes are also given. With a three-motor 70-ton crane the highest efficiency was reached when hoisting a load of 20 tons at the rate of 3·75 ft. per minute, and was calculated to be 62·8 per cent. With a load of 80 tons the efficiency was 50 per cent., the lifting being done at the rate of 2·56 ft. per minute. With a four-motor 50-ton crane an efficiency of 61 per cent. was shown with a load of 21 tons lifted at the rate of 4·5 ft. per minute, the efficiency at full load being about 45 per cent. An old 40-ton crane driven by an elaborate system of ropes, belts, spurwheels, &c., the whole being worked by a motor, showed at best an efficiency of 16·7 per cent. Other cranes were also tested, and full figures are given in each case, both for hoisting, traversing, and travelling. W. H. S.

**1427.** *Electric Percussion Rock Drills.* (Eng. News, 46. pp. 130–131, Aug. 29, 1901.)—The paper prescribes three types of percussion drills driven by electric motor. The *Durkee* electric drill has an independent motor of 1½ h.p. driving through a flexible shaft. The motion is given by a special crank which gives a slow return and quick forward or cutting stroke, the driving collar moves the drill spindle through springs so as to cushion the motion if the drill is not striking the rock, and to allow for irregularities in the feed. The drill is rotated by the usual rifled rod and pawl. The machine makes 580 strokes per minute and weighs 230 lbs. without tripod.

The *Gardner* drill is very similar. Instead of a crank a cam is used, so that the forward stroke takes ¼ of a revolution, the backward ½, and the remaining ¼ it is stationary. The drill is made in 2 sizes, with motors of 1½ and 2 h.p. weighing 150 and 200 lbs. The smaller gives 600 blows with 2½-in. stroke, the larger 500 blows of 3-in. stroke per minute. A special feature is a slipping friction clutch, to avoid blowing the motor fuse if the drill jams in the hole.

The *Hercules* drill endeavours to copy the method of hand drilling. The drill and motor in one frame are carried on a stand. The drill does not oscillate, but is slowly rotated by a rifled bar, being struck at the back by a motor-actuated hammer giving 700 blows per minute. The weight complete with stand is 400 lbs. LL. B. A.

1428. *Electrically-driven Lathe.* (Engineer, 93 pp. 292–293, March 21, 1902.)—Drawings are given of the headstock of a lathe, constructed by Herbert, and the methods are described by which variations of speed are obtained from a motor running at constant speed. In the first place a step-cone is provided, which gives three changes of speed, and in the second place there is on each of two spindles a pair of friction clutches, which in combination with the step-cone give a range of twelve speeds. The whole of the gearing is enclosed in the headstock, and all the changes of speed are effected by moving levers which are arranged on the outside. W. H. S.

1429. *Electric Hoists on the Comstock.* **L. M. Hall.** (Journal of Electricity, S.F. 11. pp. 205–206, Aug., 1901.)—The author describes a type of electric hoist for lifting ore cars from the incline mines of the Comstock. The special features are, variable speed induction motors with geared hoists, working a continuous rope system, so that there is no unbalanced rope load. The working seems to have been satisfactory, as several plants have been installed. The theoretical h.p. was 66·4, the actual 88·4 h.p., an efficiency of 75 per cent. The total weight lifted is 3,650 lbs., and the speed is from 600 to 1,250 ft. per minute. LL. B. A.

## REFERENCES.

1430. *Edison's Alkaline Accumulators.* **E. J. Wade.** (Electrician, 47. pp. 677–679, Aug. 23, 1901.)—Particulars are given from the patent specifications, of Edison's cadmium copper-oxide cell and iron/nickel-oxide cell, and the author discusses the iron oxides which are used. W. R. C.

1431. *Report on the Visit of the Institution of Electrical Engineers to Germany.* **P. S. Sheardown.** (Inst. Elect. Engin., Journ. 31. pp. 611–627; Discussion, pp. 627–629, March, 1902. Paper read before the Dublin Section of the I.E.E.)—This paper contains a detailed account of the various things that were seen on the occasion of the visit to Germany in June, 1901. W. H. S.

1432. *Wattmeters.* **H. Armagnat.** (Ind. Élect. 11. pp. 5–9, Jan. 10, and pp. 35–37, Jan. 25, 1902).—The author treats first of the dynamometer wattmeter, both of the torsion-head and direct-reading types. He discusses the errors due to mutual induction between the coils, and due to their self-induction and capacity, and shows how to find and correct these errors. He next deals with induction wattmeters and mentions briefly electrostatic instruments. G. H. B.

## GENERATORS, MOTORS, AND TRANSFORMERS.

**1433.** *Equalising Connections in Dynamo Armatures.* **E. Arnold.** (Elektrotechn. Zeitschr. 23. pp. 215–220, March 13, and pp. 233–235, March 20, 1902.)—Any two points in the winding of an armature which are always at nearly equal potentials during the rotation may be connected together, and if there is perfect symmetry in the field there will be no current along such connectors, and hence no object in using them. But since it is impossible to obtain perfect symmetry, the e.m.f.'s induced in the various sections of the winding will in general not balance each other, the current will not be uniformly distributed, and sparking at the brushes will take place. By providing the armature with equalising connectors the out-of-balance currents are made to flow through the connectors instead of passing to the brushes, where they would cause sparking. The author first considers a simplified method of representing a multipolar drum winding by reducing it to an equivalent ring winding. By means of such a "reduced" diagram the equipotential points of the winding are readily determined. The maximum resistance to be given to the equalising connectors in order that they may be effective should correspond to the constant part of the brush contact resistance (this latter may be expressed by a constant, *plus* a term which varies inversely as the current-density). The author states that the use of such equalising connectors has been attended with excellent results, not only in the case of lap-wound armatures, but also in those having unsymmetrical wave-windings, and the Elektricitäts A. G. vorm. Lahmeyer & Co., invariably employs equalising connectors in all the larger machines. Such connectors may be arranged inside the commutator, behind it, in front of or behind the armature, or even along the armature circumference. In the latter case the binding wires may be employed as equalising connectors. The use of such connectors in connection with *wave* windings is patented. A. H.

**1434.** *Armature Reaction in Alternators.* **E. Arnold.** (Elektrotechn. Zeitschr. 23. pp. 250–252, March 20, 1902.)—The author briefly reviews and criticises the various methods which have been used by different investigators for predetermining the drop which occurs in the armature of an alternator. A number of diagrams are given, including one due to the author and J. L. la Cour. The author explains in detail the calculations necessary in connection with this diagram. Referring to the increase in the leakage coefficient which takes place at full load, he states that this increase does not, in modern machines, exceed some 6 or 7 per cent. A. H.

**1435.** *Mechanical Strength of Large Alternators.* **H. Linsenmann.** (Elektrotechn. Zeitschr. 23. pp. 81–84, Jan. 30, and pp. 103–107, Feb. 6, 1902.)—The forces tending to produce a deformation of the armature in the flywheel type of generator are partly mechanical, due to the weight of the armature and the torque exerted on it when the machine is running under load, and partly magnetic, arising from the pull exerted on the armature core by each pole-piece. The forces arising from the weight of the armature and the driving torque which acts on it, constitute a stable system—*i.e.*, the increase brought about in these forces by a slight yielding of the armature is negligible. The forces arising from magnetic pulls, on the other hand, represent an unstable system, since any deformation of the armature (due to want of symmetry) under the action of such forces increases them. The author first calculates the variation of the magnetic pull with the length of air-gap. In the next section of the paper he deduces the general equations connecting the bending-moments of the stable forces with the radial deformation of the armature. Lastly, he takes into account the magnetic forces, and illustrates the practical application of the results obtained by working out a numerical example. A. H.

1436. *The Coupling of Alternators in Parallel.* **R. de Renzis.** (Assoc. Ing. Él. Liège, Bull. 1. pp. 192–210, Sept. 21, 1901. Lecture by M. Motta, read at l'École Polytechnique de Milan.)—The author states that alternators of low frequency work better in parallel than those having a high frequency. It is not always wise to have a too heavy flywheel, since it is not only constancy of speed which regulates stability, but also the lengths of the periods of oscillation of the engine and the alternator. Care must be taken to avoid placing the flywheel too far from the armature, since too long a shaft may act as an elastic connection, and in consequence increase the amplitude of the oscillation. W. G. R.

1437. *The Working of Alternators in Parallel.* **S. Hefter.** (Assoc. Ing. Él. Liège, Bull. 1. pp. 211–268, Sept. 21, 1901. Paper read before the Soc. Electrotechn. de St. Petersburgh, March 12, 1901.)—This is really a short treatise on the working of alternators, the calculations being carried out by graphical methods. The author concludes that alternators work more regularly in parallel the greater the number of poles, or, the frequency remaining the same, the greater the speed of rotation. W. G. R.

1438. *Influence of Speed Regulation of Prime Movers on the Parallel Operation of Alternators.* **C. P. Steinmetz.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 325–328, March, 1902.)—In this paper the author discusses the effect of speed variation of the prime mover—in which class he includes reciprocating engines (steam, gas, or oil), rotary engines (steam or water), and electrical motors—upon the running of alternators in parallel. Three cases are considered—permanent variations of speed due to a change of load, temporary variations due to a sudden change of load, and cyclical variations due to inequality of torque during a revolution. In the case of alternators driven by synchronous motors, an entirely different set of phenomena occurs, the reason for which is explained. Surging or hunting between the alternators is sometimes cumulative or resonating, when the prime mover has a cyclical variation of speed; this can be got rid of, either by breaking the resonance condition of the electric circuit by interference, or by damping the oscillations of the governor, or by reducing the amplitude of the hunting by a damping arrangement in the electric circuit, usually in the field of the alternators. B. P. S.

1439. *Parallel Operation of Engine-driven Alternators.* **W. L. R. Emmet.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 329–335, March, 1902.)—The author believes, contrary to the usual experience, that generators with light flywheels are more easy to operate in parallel than those with heavy flywheels. The rest of the paper deals with the author's dash-pot controller for steam-engine governors. [See Abstract No. 1175 (1900).] B. P. S.

**1440.** *Self-exciting Alternators.* **M. Latour.** (Ind. Élect. 11. pp. 101–102, March 10, and pp. 121–130, March 25, 1902.)—The author gives an account of the methods proposed by him for constructing a series-wound and a compound-wound self-exciting alternator. In each case, the induced winding of three phases is arranged on the stator core. In the series-wound machine, the three phases of the induced winding are not connected directly, but are joined to three brushes arranged (in a two-pole machine) at 120° from each other around the commutator of the inducing winding, which is identical with that of a continuous-current armature. In the compound-wound generator, the rotor is, in addition to the series winding just mentioned, provided with a shunt winding. The author briefly considers the properties of these machines. [See also Abstract No. 1235 (1902).] A. H.

**1441.** *Speed Regulation for Direct-Current Motors.* **A. Hundt.** (Elektrotechn. Zeitschr. 23. pp. 235–236, March 20, 1902.)—The author of this article, in reviewing the different systems used for speed regulation with shunt-wound motors, suggests that a better method is to vary the air-gap between the armature and poles of the motor, or, in conjunction with the usual system used, to change the current density passing through the winding of the field magnets. In this way a greater variation of speed, and less sparking at the commutator brushes, is obtained. The author describes in detail a 6-h.p., 500-volt, bipolar motor, having a speed variation from 350 to 1,500 r.p.m. with a constant efficiency of 83 per cent. The variation of air space beween the armature and poles is effected while the motor is in motion. The manner in which this operation is performed, as well as other constructional details, are shown by the author in the illustration accompanying his article. L. G.

**1442.** *Controller for Polyphase Motors.* **E. Klein.** (Elektrotechn. Zeitschr. 23. pp. 64–66, Jan. 23, 1902.)—The starting resistances, instead of being connected in series and successively cut out till all are short-circuited, are successively put in parallel. A more economical use of the material is thus attained. By permanently connecting one branch of each resistance with one of the contact rings of the rotor, the number of contacts in the controller as well as the number of cables between it and the resistances (in case these are separated) is reduced by one-third. Such a controller, made for the Murnau-Oberammergau three-phase railway, is described and illustrated. A. E. L.

**1443.** *Rougé and Faget's Rectifier.* **R. Rougé.** (Ind. Élect. 11. pp. 53–56, Feb. 10, 1902.)—Rougé and Faget's rectifier is a kind of rotary converter in which the armature is stationary while the brushes revolve. The alternate current is introduced into a Gramme ring at two points, the windings of the ring being connected up with a commutator. A steel ring with windings supplied with rectified current turns synchronously within the Gramme ring. The shaft carries the rotating brushes and slip-rings for taking off the rectified current. When used for charging accumulators the current is extremely variable, which causes periodic displacements of the neutral line of commutation. To ensure sparkless commutation under such circumstances, each commutator segment is double, one part being connected to one armature winding directly, and the other part through a resistance. The brushes are arranged in two pairs, in parallel, one brush of each pair touching one half of a segment, while the other touches the other half. Curves of the rectified current taken by an ondograph are given. G. H. B.

# ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

## ELECTRICAL DISTRIBUTION.

**1444.** *Discussion of Papers on Electric Transmission Systems.* (Amer. Inst. Elect. Engin., Trans. 19. pp. 166-187, Feb., 1902.)—**Shepherdson** concludes from Perrine's statements on the loss by brush discharge, that a solid conductor is preferable to a stranded one, and that aluminium is preferable to copper on account of the larger diameter of the wire. **Fisher** described some experiments contradicting Perrine's statement that the effect of capacity was to flatten the e.m.f. curve. A comparison between effective and maximum values of the e.m.f. were made on a 12,000-volt circuit by measurement of spark distances. When a cable of about 0·3 mf. capacity was connected in parallel the ratio of the e.m.f.'s was greater. **Emmet** thought that Scott had exaggerated the troubles to which synchronous motors gave rise. He did not consider it essential that the excitation of a synchronous motor should be adjusted to conform with change of pressure on the line. With constant excitation it tends to steady the system, and the variation of power-factor with change of load is small. **Steinmetz** thought there was no excuse ever to use an induction motor where a synchronous one could be used. A squirrel-cage motor is ideally simple, but requires the same excessive starting current as a synchronous motor ; if rheostatic control be introduced the motor loses its chief advantage of simplicity. He compares the two types of motor at length, to the advantage of the synchronous motor. **Perrine** showed that under certain circumstances the fact that a synchronous motor can act as generator may be a great advantage. **Stillwell** believed that the synchronous motor possessed one advantage only over the induction motor, namely, in improving the power-factor of the system, but that this advantage was discounted by the necessity for skilled attendants to adjust the fields. He considered that the possibility of synchronous motors falling out of step on a momentary drop of pressure a grave objection to their use. **Mershon,** referring to Perrine's paper on the loss due to discharge from wires at high pressures, said that this loss is a function of the rate of fall of potential at the surface of the wire, which again is a function of the radius of curvature and of the distance between the wires. When this distance is large relatively to the diameter of wire, the rate of fall varies but little with the distance, and depends practically only on the size of wire. The loss will probably depend on the condition of the surface of the wire, and increase as the surface becomes roughened by exposure.

The loss is greatly increased by a peaked wave-form. **Steinmetz** did not think that the loss at very high pressures would depend greatly on the condition of the surface of the wire, or be greater from a stranded cable, though at lower pressures this would be the case ; a very high pressure operates not on the actual surface of the wire, but on the conducting space surrounding it, which is filled with luminous brush discharge. Referring to synchronous and induction motors, he pointed out that the maximum torque of the former varies directly with the pressure, while that of the latter with the square of the pressure ; so that with a decrease of pressure the synchronous motor will maintain its torque longer. [See Abstracts Nos. 2024, 2285 (1901), and Nos. 411, 788, and 1220 (1902).] G. H. B.

1445. *High-frequency Oscillations in High-Potential Transmission Lines.* **P. H. Thomas.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 807–809, March, 1902. Discussion on Steinmetz's paper, Abstract No. 411, 1902.)—Referring to Steinmetz's conclusion that the interruption of a short-circuit may give rise to a p.d. far beyond the strength of any insulating material, the author points out that the assumptions on which this conclusion rests are not sound. A short-circuit is never opened instantaneously, and before a break takes place the current is considerably reduced by the resistance of the arc. Further, if an abnormally high p.d. should be reached on rupturing the circuit, the arc will be re-established. Any device specially designed to give a quick break—for example a magnetic blow-out, air-blast or break under oil—is more likely to cause a dangerous rise of potential than the open-air type of switch. A. H.

1446. *High-Potential Surges in Transmission Circuits.* **P. H. Thomas.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 189–240, March, 1902.)—The author gives a non-mathematical account of the various ways in which high-potential waves may arise in a transmission line or the apparatus connected to it. When a "dead" transformer is connected on one side to a high-potential line, one end of its coil is suddenly raised to the full line potential. Each turn of the coil has a certain capacity with respect to the neighbouring turns, and before the various turns have received the charges corresponding to the line potential, the full p.d. between line and earth will exist across the first few turns of the coil; this p.d. may be higher than that which the section of the coil concerned is able to stand, and a tiny spark may pierce the insulation; this spark is so small that it does not produce any permanent damage. If now the second terminal of the transformer be connected to the second line wire, an abrupt change of potential takes place at the corresponding end of the coil, and again the first few turns of the coil at that end may be severely strained; if a spark results, no harm is done so long as the spark is not followed by an arc. The author next considers the charging of a transmission line open at the far end. When such a line is suddenly connected to the terminals of a generator a charging current flows along the line, establishing a p.d. across it corresponding to that of the generator. When the p.d. wave reaches the far end of the line, the current does not stop but is maintained by the energy stored up in the magnetic field of the line. The discharge of this energy increases the p.d. across the far end of the line above the generator p.d., and if the damping due to the resistance of the line be neglected, the p.d. will rise to double the generator p.d. The surplus electrostatic energy due to this higher p.d. now returns to the electromagnetic form, a reflected p.d. wave running back along the line to the generator, where it is once more reflected by the choking effect of the generator coils, and so on. The wave thus runs backwards and forwards, but is soon damped out by resistance. The velocity of such a high-potential wave is so great in comparison with the changes in the generator voltage that the latter may be regarded as constant during the existence of the wave. Lightning is the most frequent source of high-potential surges in transmission lines. It is but seldom that a line is struck directly, and when this occurs near either end of the line probably no form of lightning arrester will offer much protection to the apparatus in connection with the line. The author describes a form of "static interrupter;" this is intended to reduce the potential gradient in a generator or transformer coil, which results from the sudden application of a high potential to one end of it. A simple choking-coil would have such an effect; but to render it fully effective, a very large amount of copper would have to be used, and the coil would further choke the main current as well. This difficulty is overcome in the author's "static interrupter" by connecting one terminal of a suitable condenser to the junction of a comparatively small choking-coil, the apparatus to be protected with the other terminal of the condenser being earthed. The static interrupter is not intended to supersede the lightning arrester, but to be used in conjunction with it. The arrester should be placed outside the static interrupter, *i.e.*, on the line side of the latter. The function of the static interrupter is to protect apparatus against short-circuit strains; that of the arrester is to discharge the line should the latter acquire too high a potential, and thus to prevent the formation of "earths" in the apparatus connected to the line. In two appendices to the paper, the author describes experiments illustrating the local concentration of potential in a high-tension coil, and a mechanical model illustrating the propagation of high-potential surges in a long transmission line. A. H.

**1447.** *The Loss of Voltage in Aerial Lines.* **R. de Renzis.** (Assoc. Ing. Él. Liège, Bull. 1. pp. 287–297, Sept. 21, 1901.)—This loss of voltage in aerial lines is shown to be due to the resistance of the line and to self- and mutual induction. In the case of two parallel wires, and self- and mutual induction are calculated and given respectively by $L = 1/2 - 2 \log r$, and $M = -2 \log d$, where $r$ is the radius of either wire and $d$ the distance between the centres of the two wires. W. G. R.

**1448.** *Electric Wiring System.* **A. Peschel.** (Elektrotechn. Zeitschr. 23. pp. 202–206; Discussion, pp. 206–207, March 6, 1902. Paper read before the Elektrotechnischen Verein, Jan. 28, 1902.)—The author describes his system of wiring, and the specially devised conduit, which not only replaces the ordinary tubing, but acts as a return, insuring perfect contact, and at the same time is virtually earth-connected. The advantages claimed by the author are, firstly, the price, this being much lower than that of the metal tubes usually employed, and as the contact between the different parts making up the conduit is not made through screwing nipples or sockets, &c. the pipes have not to be threaded, and can therefore be made thinner and lighter. The tubes used are made of tinned iron sheets, rolled in such a manner as to leave a longitudinal slot, which permits the tube fitting on to any socket which is a little larger, and making perfect contact. Wall sockets, switch and fuse boxes, as well as other accessories, are carefully designed by the author, as is shown in the illustrations accompanying the paper. The longitudinal slot in the tube permits of perfect ventilation, and as the tubes are to be fixed with the slot downwards, no water can accumulate in them. The author admits that sometimes a bare wire may advantageously be drawn into the tube, and connected to it, in order to ensure a perfect and safe return. In comparing this system with several others usually employed, the author thinks that this system is much cheaper, and at the same time safer, assuming material of the best quality to be employed. He shows how the system can be applied to alternating monophase or polyphase current circuits, and to direct-current circuits. The use of the outer tube as a return simplifies the installation for electric lighting considerably, and is a safe system. *Discussion.*—**Levermann** said that a similar system was employed for the last ten years for the wiring of ships, in the cases where the body of the ship was used for the return. The system could advantageously be employed for surface wiring. **Passavant** said that the system used in Stuttgart, where a bare middle wire is used for return and earthed, proved to be a success, but did not prove to be the same in Berlin, and the reason for it, he thought, lay in the difference of the nature of the mortar used. He also expects in this system that some corrosion of the tube may take place through electrolytic action. **C. L. Weber** thought that the limesalts of the mortar used might affect the insulation of the wire drawn through the conduit, and would like to know, therefore, whether any precautions have been taken to stop up the slot, in case the conduit has to be buried in the mortar? The **Author,** in reply, said that, by introducing a bare wire connected to the conduit, a safe return is ensured, and the tube acts as a very good protection, and as the insulated wire is usually drawn into the conduit after the mortar has had time to dry, there ought not to be any chance of moisture affecting the insulation. He has, however, devised means to prevent the entrance of mortar into the conduit. The paper is fully illustrated. L. G.

## ELECTRICITY WORKS AND TRACTION SYSTEMS.

1449. *Power Transmission from St. Moritz to Lausanne on the Constant Current System.* **E. Bignami.** (Elettricità, Milan, 21. p. 164, March 16, 1902.)—The town of Lausanne acquired in 1898 a water-power of 10,000 to 15,000 h.p. on the Rodano at St. Moritz, 56 km. distant from Lausanne. A committee of five experts examined the tenders sent in for different systems, and selected the Thury system of constant continuous current at 23,000 volts. [See Abstract No. 1369 (1900).] The amount of the tender was 7,365,000 francs, while that of the three-phase system was 8,005,000 francs. The present installation provides for 5,000 h.p. The generating station contains five turbines by Escher-Wyss, each developing 1,000 h.p. at 300 r.p.m. under a head of 82 m. Each drives directly two dynamos, each of which gives 150 amperes at 2,300 volts. The five pairs of dynamos are connected in series and give 23,000 volts. There is no switchboard, but each set is provided with a cast-iron column on which are mounted a short-circuiting switch and an ammeter. A set is put into circuit by opening the turbine regulator till the dynamos give 150 amperes, when the short-circuiting switch is opened. The line, 54 kw. long, consists of two bare copper cables of 150 sq. mm. section, run on insulators. The Lausanne station at Pierre de Plan contains at present five motors of 400 h.p. each at 2,150 volts. Each motor has a small switchboard containing a voltmeter, an ammeter, and two short-circuiting switches, one automatic and the other operated by hand. Each motor also has an automatic regulator which shunts the field and shifts the brushes. Four of the motors drive three-phase generators supplying current at 800 volts for light and power in Lausanne. The fifth motor drives a continuous-current dynamo for the tramways, for which is installed a battery of accumulators and a booster. Plant for transmitting a further power of 5,000 h.p. will shortly be installed. G. H. B.

1450. *Rhyl Electricity Works.* (Elect. Engin. 29. pp. 438–443, March 28, 1902.)—This station is worked in connection with a dust destructor. There are two Babcock boilers, each giving 5,000 lbs. of steam per hour, and also two smaller ones, each evaporating 2,000 lbs. of water per hour ; the latter can either be fired by coal or by means of the destructor gases. The destructors consist of four cells, each burning 10 tons a day. The small boilers are placed immediately above the destructors, by which they are fired, and the others are placed at the end of the destructor house away from the engine-room but near the chimney. The generating plant includes three 150-kw. six-pole machines giving 300 amperes at 500 volts. There is also a balancer-booster set and a motor-driven tramway booster, which can raise the pressure 100 volts and has a capacity of 2½ kw. The accumulators consist of 274 cells, having a capacity of 25 kw. for nine hours. The crane lifts 4 tons, and has a span of 30 ft. 6 in. The distributors have a section of 0·125 sq. in., and the arc lamps are run ten in series on 500 volts. W. H. S.

1451. *Worksop Electricity Works.* (Elect. Rev. 50. pp. 288–290, Feb. 21, 1902.)—This direct-current station has two Lancashire boilers, 30 ft. by 8 ft., working at 125 lbs. per sq. in., and a chimney 150 ft. high and 5 ft. 6 in. in diameter. The engine-room is 56 ft. long and 28 ft. broad, with a height of 22 ft. to the bottom of the roof trusses. The generating plant includes one 150-kw. and two 100-kw. steam dynamos; the steam consumption of the larger set on test was found to be 25·8 lbs. per kw.-hour, running condensing, the speed being 400 r.p.m. The balancer-booster set consists of four coupled machines, running at 1,200 r.p.m., each of the balancers having an output of 7 kw. The battery consists of 240 cells, having a rated capacity of 180 ampere-hours. W. H. S.

1452. *Nelson Electricity Works.* (Elect. Engin. 29. pp. 474–476, April 4, 1902.)—This continuous-current station contains two Lancashire boilers 30 ft. by 8 ft., an economiser of 192 tubes, three 200-kw. steam dynamos, compound wound, and a battery of 268 cells, giving 70 kw. for 10 hours. W. H. S.

1453. *Lighting of the Cornwall Canal, Canada.* (Elect. World and Engineer, 39. pp. 388–390, March 1, 1902.)—The generating station contains at present one 1,000-kw. three-phase alternator, running at 180 r.p.m., driven by water-power; three similar units are to be further installed. The frequency is 60 cycles per second, and current is delivered at 2,200 volts. The pressure is transformed in a tower, which is built adjoining the power-house, to 11,000 volts for the power-transmission circuits, and also to 8,800 volts for use in connection with the 100-light circuits of series enclosed alternating arc lamps. At the present moment there are 250 arc lamps distributed along the canal, and power is used for operating canal gates, swinging bridges, &c., the pressure being again transformed to 500 volts for use with induction motors. It is expected that later a considerable amount of power will be utilised in connection with various enterprises which are situated on the banks of the canal. The tower contains on the ground-floor the high-tension switchboard, on the next floor the step-up transformers, and on the top floor the lightning arresters and the distributing cables. The water-wheels driving the large generator are arranged in two pairs with a fifth wheel used only in case of high backwater, the working head being 30 ft. W. H. S.

1454. *Power Transmission at Hartford, Conn.* **A. D. Adams.** (Elect. World and Engineer, 39. pp. 427–434, March 8, 1902.)—The system used for the electrical supply in Hartford, Conn., includes three generating plants, two driven by water and one by steam; a substation of transformers and rotary converters in connection with the steam plant; a separate substation with transformers, rotary converters, and a large storage battery; and two transformer stations for street lighting with series arcs. The two water-power plants are located on the Farmington River, which rises among the Berkshire Hills of Western Massachusetts, more than 50 miles above the electrical power stations. The system permits of either the steam or the hydraulic plants, as may be required, carrying any desired portion of the total service load. The head of water available at the plant in East Granby, near the village Tariffville, which is over 11 miles distant from the steam plant, is 28 ft.; and that at the station in Windsor, at the point called Rainbow, about 105 miles from the steam plant, is 32 ft. The water-power station at Rainbow was put in operation during November, 1891, and the plant comprises two 600-kw., 500-volt, 60-cycle, two-phase Westinghouse generators, each belt-connected to a horizontal turbine wheel. This plant also contains four oil-cooled transformers, each of 300-kw. capacity, which are used for raising the pressure from the generators to 10,000 volts, and changing it in three-phase. The second hydraulic plant, which is situated 8 miles away from the first, has been in operation since November, 1899, and comprises two Westinghouse generators, each direct-coupled to a horizontal turbine wheel. Each of these generators has a capacity of 750 kw. at 500 volts, and the pressure is raised to 10,000 volts three-phase by transformers. The third plant is a steam plant in Hartford, containing one 600-kw. and one 400-kw. generator, each driven by belting from an independent steam engine. Besides these generators, this station contains a 1,500-kw. alternator direct-connected to a steam turbine, all of Westinghouse make. The turbine alternator runs at 1,200 r.p.m., and delivers energy at 2,400 volts and 60 cycles two-phase. The output of the system at full load is rated at 5,200 kw. The author points out that this steam turbine unit is the largest that has ever been built. The outfit weighs, including the generator, 175,000 lbs., and occupies a floor space of 33 ft. 8 in. long and 6 ft. 9 in. wide. The turbine is entirely automatic in all its functions, and requires very little attention. There are no rubbing surfaces, and consequently there is no necessity for internal lubrication, so that superheated steam and surface condensers may be employed to the greatest advantage. The steam-power station contains two rotary converters of 400-kw. capacity each, and four 375-kw., four 300-kw., and four 200-kw. transformers. At the battery substation on State Street, are two 250-kw. and one 300-kw. rotary converters, together with transformers of equivalent capacity, also a battery with 140 cells and a capacity of 17,000 ampere-hours. Two other substations, at opposite sides of the city, contain constant-current transformers which supply series circuits for alternating arcs. Each of the water-power plants is connected by an independent line with the steam-power station at Hartford. The 600, the 400, and 1,500-kw. generators of the steam plant deliver their energy at 2,400 volts to the same switchboard that receives the current from the transformers connected with the water-power plants. The author describes fully the system of transmission and distribution of the power generated at the different substations. Energy obtained from the water power is absorbed by the batteries during periods of small load, and the batteries discharge into the outside conductors of the three-wire system in the usual way. Where motors are supplied with alternating current, they are of the two-phase type, the two wires of each phase being brought to the motor. Arc and incandescent lamps are supplied from independent circuits representing each phase. Economy in the production of steam power at Hartford is sought by the use of the steam turbine above mentioned, of condensers with the engines, and of three large cooling towers, in which the water from the condensers is subject to a mechanical draught of air while passing over layers of unglazed tiles. Fans for the production of this draught are driven by electric motors. The author gives statistics of the increase in output from the years 1892 to 1901, and also of the increase of income derived from the different uses of electricity for lighting and motive power. The Hartford system, in 1892, operated only 4,850 incandescent lamps, 476 public arc lamps, and 308 arc lamps used for commercial purposes; whereas at the end of 1901 there were connected 72,085 incandescent lamps, 643 public arc lamps, and 971 arc lamps used for commercial services. The number of motors connected in the year 1901 was 480—consuming 3,476 h.p. A very large motor load has been secured for the Hartford system, and the increase amounted to 945 per cent. in the 10 years mentioned. Since the second water-power station has been started, only a small fraction of the energy delivered has been generated from coal, except at those times of the year when the supply of water has been too small to meet the full demand. The output of the entire system in the year 1901 was 8,577,699 kw.-hours, and of this only 1,009,598 kw.-hours were developed by steam power. During five months of the year 1901, more than 98 per cent. of the total output was obtained from water power, yet, in February, the steam plant was required to develope 54·5 per cent. of the total energy. The author suggests that more attention should be given to the storage of the surplus water available, for use at the drier seasons of the year, reducing thereby the size of the steam plant, which is now almost idle during several months in the year. The total consumption of coal was 5,496 tons in the year 1892, and increased only to 6,306 tons in the year 1901. After a careful consideration of the different items which contributed to make the Hartford system a success, the conclusion arrived at is that water powers are to-day much the most important of the known factors by which the cost of electrical energy may be reduced. The paper is fully illustrated.

L. G.

1455. *Electric Generating Station at New Rochelle, N.Y.* (Amer. Electn. 14. pp. 108–110, March, 1902.)—The system is two-phase alternating, 60-cycle, 2,300 volts. At two substations, step-up transformers raise the pressure to 4,400 volts for street lighting distribution. The boiler- and engine-rooms run side by side; the former, 117 ft. 6 in. long by 45 ft. wide, contains at present 4 Stirling boilers, each rated at 250 h.p. and working up to 150 lbs. pressure per sq. in. The boilers are hand-fired from charging trucks which run on rails in front of the furnace doors. The feed-water pipes are in duplicate, and consist of 3-in. wrought-iron mains and 2½-in. brass branch pipes. The feed pumps are in the boiler-room, and are of the Duplex pattern. The steam-piping, of which plan and elevation are given, is in duplicate. It is extra heavy, and the flanges and fittings are of cast steel. Plan, elevation, and sectional views of the condenser piping and intake are given, as are also the pipe sizes. The engine-room is 117 ft. 6 in. long, by 54 ft. wide, and contains one 200-kw. Stanley alternator driven by belt from a horizontal compound tandem engine 13 in. and 23 in. by 17 in.; two horizontal cross-compound engines 18 in. and 36 in. by 42 in., each directly connected to a 500-kw. Westinghouse alternator of the revolving field type, running at 100 r.p.m.; two simple horizontal engines, each directly connected to a 25-kw. direct-current Westinghouse generator, running at 300 r.p.m. The large engines are designed for an economical load of 750 h.p. when supplied with steam at 160 lbs. pressure at the throttle valve, and exhausting into a condenser having a vacuum equal to 26 in. [The boiler pressure is given as 150 lbs. per sq. in.] The bearings are lined with Babbitt metal, and water-jacketed, and are provided with wedge adjustment. The governors are of the weighted Watt type driven by gearing, the spindle and rocking shaft working in ball bearings. The valves, which are of the pendant double ported Corliss type, are driven by separate eccentrics, and the cut-off can be carried to three-quarter stroke. The flywheel is 18 ft. in diameter, and weighs 70,000 lbs. It is of the segmental rim type. The switchboard permits of paralleling the machines. The front of the board contains only instruments and switch handles, all switches and live metal being behind. The bus-bars and shunt regulators are located in the basement, the handles of the latter being mounted in pillars standing in front of the board. The sizes of bus-bars, and other details, are given. Private lighting is carried out at 104 volts through transformers fixed on the street poles. F. B.

**1456.** *Middleton Electric Lighting and Tramways.* (Electrician, 48. pp. 969–973, April 11, 1902.)—This article deals with a small municipal electricity supply works, just opened at Middleton. The works will supply a small private lighting load in the town, nine public arc lamps to start with, and the Middleton Electric Traction Company's lines. The tramway lines were built by the British Electric Traction Company, and have a total length of 8¼ miles of single track, with turn-outs, and are on the ordinary trolley system. The lines will possibly form an important link of intercommunication in the district, as the line to the south-west extends to the Manchester boundary, on the north it enters the borough of Rochdale, and to the east terminates at the boundary of the Oldham borough. There are 20 cars in all, 10 supplied by the Electric Railway and Tramway Carriage Works (Preston), and the other 10 by the Brush Electrical Engineering Company. All are of the double-truck type, and each is equipped with two 25-h.p. motors with single reduction gear. The lighting mains are on the 2 by 220 volts continuous-current three-wire system. The power-house contains three 250-kw. Belliss-Siemens sets, the dynamos being shunt-wound, with additional over-compounding coils for use on the traction circuits. Besides a switchboard for the lighting and one for traction, the equipment of the station includes a 50-kw. motor generator, so that at times of light load, both lighting and traction can be supplied from one main generator. The steam plant includes three Lancashire boilers, 30 ft. by 8 ft., and a 256-tube economiser. A Belliss surface-condensing plant is employed, capable of dealing with the exhaust steam from two of the engines. Circulating water is obtained from the river, and returned to it, no cooling tower or pond being necessary.

J. L. F. V.

**1457.** *Grand Rapids, Holland and Lake Michigan Railway.* **G. A. Damon** and **W. D. Ray.** (Street Rly. Rev. 20. pp. 127–137, March, 1902. Paper read before the Chicago Electrical Association, March 7, 1902.)—This line is 45 miles long, and runs for the most part through more or less open country. The power-house contains two 500-kw. three-phase alternators, and distribution is effected through rotary converters. The transmission wires are of aluminium, and carry current at 20,000 volts; the wires are placed 24 in. apart at the corners of an equilateral triangle. They are fixed to Provo glass insulators, weighing 6 lbs. each, with a diameter across the base of 7½ in. Glass insulators are supposed to be better than porcelain, and cost less. They do not require to be tested, and the life without deterioration is said to be longer. W. H. S.

1458. *High-tension Three-phase Railway at Wöllersdorf Arsenal.* **F. Golwig.** (Zeitschr. Elektrotechn., Wien, 20. pp. 133–138, March 16, and pp. 150–153, March 23, 1902.)—This is a short length of line connecting the arsenal with the steam railway line. Power is taken from an already existing station in the arsenal, which supplies current at 3,000 volts, and 42 cycles. The locomotive has a 50-h.p. motor, which drives one of the axles by means of toothed gearing. There is room for a second motor, in case it should later be found necessary. There are two overhead wires, the rails carrying the current in the third phase. There are two overhead collectors; only one is used at a time, and each corresponds to motion in a given direction. The collector is composed of two trolley-poles connected at the top by two copper rollers, which are insulated from one another. In the base of the trolley-pole there is a pneumatic cylinder, which can be operated by the driver, and causes the collector to be raised or lowered. The high-tension cables are supported on specially shaped porcelain insulators, spaced at distances of 4 in., and are, moreover, protected by iron tubing, which is connected with the roofing and framework of the truck. Sketches are given showing the construction of the locomotive, and a diagram gives the various pneumatic and electrical connections. The only parts in the driver's cabin which carry high-tension current are the distributing box and the main switch. Both are enclosed in cast-iron boxes, which are fastened by a special key; this key is so locked with the pneumatic apparatus that it can only be removed, and the boxes can consequently only be opened when both the overhead trolleys are lowered. The trolleys can only be raised again after the key has been replaced. The speed of the motor is 600 r.p.m., and the gearing is in the ratio of 6 to 1. The current in the rotor is controlled by a liquid rheostat, the rate at which the resistance is cut out depending on the operation of a dash-pot, worked by pneumatic pressure. The air compressor is worked by a 2-h.p, 100-volt motor, and gives a pressure of 4 atmospheres. The overhead conductors consist of two hard-drawn copper wires, 8 mm. in diameter, placed 87 cm. apart, and 6 m. above the level of the rails. The sections of the line which are in the terminal stations are normally switched free of current. The line, which is about 1 km. in length, has been constructed by Ganz on behalf of the Austrian Government. W. H. S.

1459. *Varese-Luino Electric Railway.* (Elettricità, Milan, 21. pp. 184–187, March 23, 1902.)—The present article deals principally with the hydraulic generating station. This is at Ferrara, and water is taken from the river Margorabbia near Ponte Natio. This river is liable to run very low in times of drought, and in consequence a reservoir of 500,000 c.m. has been formed by damming the Lago di Ghirla; an auxiliary reservoir near the intake of 10,000 c.m. capacity has also been made. A canal 300 m. long leads to a pipe-line 530 m. long; the pipes are 75 cm. in diameter, and from 5 to 8 mm. thick; the available head is 107 m. Three Pelton wheels by Riva, Monneret & Co., take each 340 litres per second, and develope 375 h.p. at 450 r.p.m. They drive directly three three-phase generators, giving each 250 kw. at 6,000 volts, and 45 ∿. The exciters are driven by belts from the generators. The turbine efficiency at full load is 78 per cent. The high-tension line is carried for the most part on the trolley-wire poles, and feeds 9 transformer stations. The trolley wires, fed from the low-tension side of the transformers, are two in number, of 8 mm. copper. The third conductor is formed by the rails. The railway is 25 km. in length, and runs on Vignole rails carried on oak sleepers. G. H. B.

1460. *The Vevey-Mont Pèlerin Funicular Railway.* **H. Muraour.** (Elettricità, Milan, 21. p. 182, March 2, 1902.)—The length of the line is 1,577 m., and the height ascended 412 m. The gradients vary from 15 per cent. to 54 per cent., and the sharpest curve has a radius of 274 m. There are five stations on the route—Vevey, Corseaux, Beausile, Chardonne-Fougny, and Baumaroche—and these are arranged so that the ascending and descending cars stop simultaneously at two stations. The two cars are attached to a cable 1,600 m. long, passing over guide pulleys along the line, and over two pulleys in the station at the summit, one of which is the driving pulley. It is driven through gears and a belt by a motor of 80 h.p. Current is supplied from a station at a small distance. In this two gas engines of 25 h.p. each, working with Dowson gas, drive a dynamo giving current at 250 volts. A battery of accumulators of 400 ampere-hours' capacity is connected across the line, and is charged by the motor acting as a generator when either car is descending the gradient of 54 per cent. There are various safety devices at the station and on the cars. On the shaft of the driving pulleys is a band brake, which acts automatically if the speed is too high and cuts off the current. On the cars are two automatic brakes which grip the rails; a third brake is operated by hand, and, in case of the cable breaking, the axles in rotating close up the bearings by an endless screw gear. An overhead line enables the conductor to signal to the station to stop the motor. G. H. B.

1461. *Power Transmission at the Webster Coal-Mines.* **W. B. Clarke.** (Elect. World and Engineer, 39. pp. 541–543, March 29, 1902.)—The author gives a description of some early types of electrical mine locomotives, and then a description of a modern plant erected at the Webster Coal and Coke Company's mine at Ehrenfeld, Pa. The chief feature is 5,600-volt, 25-period, 5,600-volt three-phase transmission to a substation in the mine 9,000 ft. from the power-house, and conversion to a continuous current of 275 volts, which works the haulage locomotives which have 80-h.p. motors. The description is illustrated. Ll. B. A.

1462. *Electric Mining Installation in the Riebeck Mines.* **E. Beutom.** (Écl. Électr. 29. pp. 423–430, Dec. 21, 1901.)—This installation, executed by the A. E. G., of Berlin, has some novel features. The motive power consists of two Korting four-cylinder Korting gas engines of 125 h.p. each, actuated by gas distilled from coal, which is treated to a dry heat for the production of paraffin. This gas has a calorific power of 1,800 calories per cm. compared to 5,500 for oil gas. The transmission is at 3,000 volts and the motors work at 500 volts, transformers being used. The most novel feature is a hoist used for carrying workpeople into the pits. It is driven by a three-phase induction motor, and has a special regulating apparatus, with three brushes working on a series of contacts arranged like a commutator, by which it may be started, stopped, and reversed. A friction brake is provided, but in ordinary work the braking is effected by running the motor as a generator returning current to the line. The description is illustrated with photo blocks of the plant. Ll. B. A.

1463. *Power Transmission at the Thiederhall Mine.* **F. C. Perkins.** (Electricity, N.Y. 22. pp. 115–116, March 5, 1902.)—The author describes a plant installed by Siemens & Halske in this mine in Germany for working a winding engine or hoist on a level 300 m. below ground. The features are a 60-h.p. engine and dynamo running continuously and charging accumulators, from which the two 150-h.p. motors (300 h.p. total) working the hoist are supplied. These can be worked in series or parallel giving a wide range of speeds. Lowering is done by running the motors as generators. Hand and automatic mechanical brakes are also in use. Ll. B. A.

## ELECTRIC TRACTION AND AUTOMOBILISM.[1]

**1464.** *Calculations of Energy and Costs of Electric Tramway Systems.* **G. Guéroult.** (Écl. Électr. 29. pp. 351–356, Dec. 7, 1901, and 30. pp. 428–429, March 22, 1902.)—The first of this series of papers deals with the methods of calculating the hourly or daily amount of energy to be supplied to a car in terms of the weight, mean normal velocity, &c. Various cases considered are the actual starting, establishment, and maintenance of the normal speed, whether on the level or on ascending or descending grades or rounding curves. Equations are deduced by which the energy required in different cases may be calculated. The values of the different coefficients which enter into the equations are given, both the theoretical values and those deduced from actual experience. The final results are as follows for a mean speed of 8 m. per second: (1) The number of kilowatts to be generated at the station per car, empty or full, is found by multiplying its weight in either case by 0·0008; (2) the ratio of the number of kilowatt-hours corresponding to 1 kilowatt-car is obtained by multiplying the weight of the car considered by 0·0006; (3) the time occupied in accelerating from rest to full speed should be from 5 to 7 seconds, or longer for a higher mean speed.

In the second part of the paper the question of costs is considered, and a more rational method of evaluating the standing and running charges is described than the usual one of specifying them in terms of the kilowatt-car. The author divides the cost into two main heads: (1) Expenses proportional to the time of running and to the number of cars; (2) fixed charges, independent of the number of cars actually running, such as administration expenses, insurance, &c. Lastly, the question of tariff is considered, and that of the relative advantages of the trolley as against conduit and battery systems is briefly touched upon and decided in favour of the former. The comparative failure of the Paris tramways as paying concerns is attributed to the excessively low tariff combined with the great length of the runs.

B. P. S.

**1465.** *Cost of Power for Electric Traction.* **A. D. Adams.** (Street Rly. Rev. 20. pp. 147–149, March, 1902.)—This article deals with the cost of power used on tramways in Massachusetts. The figures given relate to the cost per car-mile, and to the number of passengers carried per car-mile. The Boston Elevated Railway ran over 38 million car-miles in 1900, power cost them 1·36 cents per car-mile, and they carried 5·26 passengers per car-mile. Similar figures are given for 43 other railways in the State, the highest cost of power being on the Worcester and Webster line, which ran 240,000 car-miles at a cost for power of 5·7 cents per car-mile; the lowest cost was on the Newton and Boston line with 535,000 car-miles, run at a cost for power of 1·31 cents per car-mile. The figures do not, however, show that any definite relation can be traced between the size of a line and the cost of power, though in general the author considers that the larger systems more frequently adopt methods of construction and operation that lead to high efficiency. W. H. S.

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[1] Non-electrical Automobiles are described in the section dealing with steam and gas engines.

**1466.** *Electric High-Speed Railways.* **L. v. Reymond-Schiller.** (Zeitschr. Elektrotechn., Wien, 20. pp. 109–112, March 2, 1902.)—This is the conclusion of a series of articles. [See Abstract No. 1255 (1902).] Experiments on two electrical street railways at Budapest are quoted which furnish data for the calculation of the possible speed with different gradients, and it is concluded that a broad track is essential for high-speed railways with ordinary gradients. A train run on a gauge of 4·5 m., having a locomotive weight of 120 tons, and with two coaches of 240 tons provided with seats for 200 passengers, would require for a speed of 250 km. per hour as much as 20,000 h.p. This apparently Utopian figure the author thinks ought to be seriously considered in view of the facility of electrical transmission of energy by high-pressure alternating currents. W. W. H. G.

**1467.** *Electric Street Railways in Chicago.* **E. B. Ellicott.** (West. Electn. 30. pp. 141–142, March 1, 1902.)—This is a report by the city electrician to the authorities, who instructed him to consider the "physical condition" of the important street railways in Chicago. He reports that the Union Traction Company has 600 miles of track; but the use of a small trolley wire and an inadequate system of connecting the feeders to the trolley are undesirable features. The safe carrying capacity of the trolley wire is 140 amperes; feeders are connected to it every 200 ft. in congested districts, and every 800 ft. in outlying districts. But in congested parts the overhead wire has not a sufficient capacity to furnish the amount of current required to work the cars at a proper speed. On a certain section of the line which appears to be near the centre of the town, the transmission losses are estimated at 33 per cent., but a large percentage of this is probably lost in the return circuits, which are said to be insufficient and composed of poorly bonded rails. The motors are geared for a maximum speed of 15 miles per hour, but during the busy hours the maximum speed is about 11 miles an hour, and in the congested district the power is insufficient to propel a loaded car at a greater speed than 6 miles an hour. The Chicago City Railway Company has 200 miles of track, and uses a large-sized trolley wire. But they, too, have a district which is seriously congested, and where the cars are only worked at 4 miles an hour. On this section during busy hours the transmission losses are estimated at 50 per cent. The steam plant of this company is said to be very much out of date, and with the use of better machinery the author estimates that a saving of 33 per cent. could be effected in the coal consumption. He also considers that the times occupied in getting the cars up to full speed and in stopping them are unnecessarily long, and though this may contribute to the consumption of a smaller amount of power, this probably contributes to accentuating the congested state of the traffic. W. H. S.

**1468.** *Report on the Accident on the Liverpool Overhead Railway.* (Engineer, 93. p. 319, March 28, 1902.)—An abstract of the report by the Board of Trade is here given. The evidence showed that the insulation of a cable connected to the motor at the end of the train had become defective; an arc was started, the rush of current opening the circuit breaker, and stopping the train. The driver, however, repeatedly tried to start the train by closing the circuit breaker, with the result that the end of the train was eventually set on fire. The rear motor should have been disconnected and the journey continued with one motor only, as is always done if one of the motors breaks down. The report concludes by pointing out that flexible cables covered with rubber or other combustible material should not be used on the main current conductors of electric trains. These conductors should be rigid, and might be bare or enamelled, or protected by incombustible ferules in iron pipes. Flexibility should be restricted to necessary points, and should be provided by pinned hinge and knuckle joints, shunted by bare flexible links of wire gauze, or by some other sound mechanical mode of construction. Little or no wood should be used in the construction of electric locomotives, and the resistances and controlled switches should be placed, if possible, in front of and outside the driver's cab. W. H. S.

1469. *Surface-Contact Systems.* **W. Kingsland.** (Inst. Elect. Engin., Journ. 31. pp. 879–880; Discussion, pp. 880–883, April, 1902.) (Abstract.)—The author described the various systems, and drew more particular attention to his own [see Abstract No. 942 (1900)]. He said that, instead of the star-wheel switch, which he had originally proposed, he now intended to employ one lever arm only, which could be pressed down by the striker, and returned automatically so as to be ready for the next stroke.

*Discussion.*—**V. Bornand** said he had superintended the laying of one of the lines in Paris on the Claret-Vuilleumier system, in which one switch operates a number of studs. It is working successfully. The switch can be placed under the pavement or road; the insulation used is mica, and the accumulation of moisture or gases is prevented by ample ventilation. If vulcanite, indiarubber, or bitumen enter into the composition of the insulating material, any sparking produces decomposition, and explosions have occurred owing to these gases being confined in air-tight switchboxes. **J. C. Vaudrey** pointed out that on the Claret-Vuilleumier system, the concentration of coils and magnets and cables in a large cast-iron box about 2 ft. in diameter in the street seemed likely to be unsatisfactory and would probably break down owing to moisture. The **Author,** in reply, said this system had been working since 1896. He proposed to put his own stud in a concrete block, and it would be almost impossible for a pool to form round it, as was alleged to happen in Paris. A large number of horses had been killed in Paris, but it was believed that they had all been killed by the Diatto system [see Abstract No. 1992 (1899)], which employed a mercury contact, and a plunger, which was drawn up in a very small switchbox, there being, therefore, a great liability to heating. There would be no sparking whatever in his own switchbox, providing the switches were operating properly and one came on before the other came off. W. H. S.

1470. *Permanent Way.* (Railroad Gazette, 34. pp. 203–205, March 21, and pp. 220–223, with Discussion, March 28, 1902. Extracts from the Report of the Committee of the American Railway Engineering and Maintenance-of-Way Association.)—*Track.*—The Committee in its report considers the following subdivisions of its subject: Maintenance of line; maintenance of surface; maintenance of gauge; inspection of track and track tools. They are all discussed in detail. In considering the subject of the super-elevation of the outer rail in curves, the Committee recommend for ordinary practice, as giving the essentially correct theoretical elevations, the formula $E = GV^2/32{\cdot}16R$, where $E =$ elevation in feet, $G =$ standard gauge, $V =$ velocity in feet, $R =$ radius of curve in feet. Since the elevation required is a function of and depends upon the train speed, speed is the first element to be determined. It is not unsafe to run over a curve at a higher speed than that for which it is elevated; a train may safely run 10 miles per hour over a curve which has no elevation, or 60 miles per hour over a curve elevated for 50 miles per hour; but the practice is not recommended. The Committee advocated originally for ordinary practice a maximum elevation of 7 in., although on the subject being thoroughly discussed a difference in elevation of 8 in. was finally recommended. The above formula gives results expressed in the following table:—

VELOCITY IN MILES PER HOUR.

| DEG. | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | DEG. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | $\frac{1}{16}$ | $\frac{1}{8}$ | $\frac{1}{4}$ | $\frac{3}{8}$ | $\frac{5}{8}$ | $\frac{13}{16}$ | 1 | $1\frac{3}{8}$ | $1\frac{5}{8}$ | 2 | $2\frac{3}{8}$ | $2\frac{3}{4}$ | $3\frac{1}{4}$ | 1 |
| 2 | $\frac{1}{8}$ | $\frac{5}{16}$ | $\frac{1}{2}$ | $\frac{7}{8}$ | $1\frac{3}{16}$ | $1\frac{5}{8}$ | $2\frac{1}{8}$ | $2\frac{5}{8}$ | $3\frac{1}{4}$ | 4 | $4\frac{3}{4}$ | $5\frac{1}{2}$ | $6\frac{1}{2}$ | 2 |
| 3 | $\frac{1}{4}$ | $\frac{1}{2}$ | $\frac{3}{4}$ | $1\frac{1}{4}$ | $1\frac{3}{4}$ | $2\frac{3}{8}$ | $3\frac{1}{8}$ | 4 | $4\frac{7}{8}$ | 6 | $7\frac{1}{8}$ | $8\frac{3}{8}$ | ... | 3 |
| 4 | $\frac{1}{4}$ | $\frac{5}{8}$ | $1\frac{1}{16}$ | $1\frac{5}{8}$ | $2\frac{3}{8}$ | $3\frac{1}{4}$ | $4\frac{1}{4}$ | $5\frac{3}{8}$ | $6\frac{5}{8}$ | 8 | ... | ... | ... | 4 |
| 5 | $\frac{3}{8}$ | $\frac{3}{4}$ | $1\frac{5}{16}$ | $2\frac{1}{16}$ | 3 | 4 | $5\frac{1}{4}$ | $6\frac{5}{8}$ | $8\frac{1}{4}$ | ... | ... | ... | ... | 5 |
| 6 | $\frac{7}{16}$ | $\frac{15}{16}$ | $1\frac{5}{8}$ | $2\frac{1}{2}$ | $3\frac{9}{16}$ | $4\frac{7}{8}$ | $6\frac{5}{16}$ | 8 | ... | ... | ... | ... | ... | 6 |
| 7 | $\frac{1}{2}$ | $1\frac{1}{16}$ | $1\frac{7}{8}$ | $2\frac{7}{8}$ | $4\frac{1}{8}$ | $5\frac{5}{8}$ | $7\frac{3}{8}$ | ... | ... | ... | ... | ... | ... | 7 |
| 8 | $\frac{9}{16}$ | $1\frac{1}{4}$ | $2\frac{1}{8}$ | $3\frac{5}{16}$ | $4\frac{3}{4}$ | $6\frac{1}{2}$ | $8\frac{3}{8}$ | ... | ... | ... | ... | ... | ... | 8 |
| 9 | $\frac{5}{8}$ | $1\frac{3}{8}$ | $2\frac{3}{8}$ | $3\frac{3}{4}$ | $5\frac{3}{8}$ | $7\frac{1}{4}$ | ... | ... | ... | ... | ... | ... | ... | 9 |
| 10 | $\frac{11}{16}$ | $1\frac{1}{2}$ | $2\frac{5}{8}$ | $4\frac{1}{8}$ | $5\frac{5}{16}$ | $8\frac{1}{16}$ | ... | ... | ... | ... | ... | ... | ... | 10 |
| 11 | $\frac{3}{4}$ | $1\frac{11}{16}$ | $2\frac{7}{8}$ | $4\frac{1}{2}$ | $6\frac{1}{2}$ | $8\frac{7}{8}$ | ... | ... | ... | ... | ... | ... | ... | 11 |
| 12 | $\frac{7}{8}$ | $1\frac{7}{8}$ | $3\frac{1}{8}$ | 5 | $7\frac{1}{8}$ | ... | ... | ... | ... | ... | ... | ... | ... | 12 |
| 13 | $\frac{7}{8}$ | 2 | $3\frac{7}{16}$ | $5\frac{3}{8}$ | $7\frac{3}{4}$ | ... | ... | ... | ... | ... | ... | ... | ... | 13 |
| 14 | 1 | $2\frac{1}{8}$ | $3\frac{11}{16}$ | $5\frac{3}{4}$ | $8\frac{3}{8}$ | ... | ... | ... | ... | ... | ... | ... | ... | 14 |
| 15 | $1\frac{1}{16}$ | $2\frac{5}{16}$ | $3\frac{15}{16}$ | $6\frac{1}{4}$ | $8\frac{7}{8}$ | ... | ... | ... | ... | ... | ... | ... | ... | 15 |
| 16 | $1\frac{1}{8}$ | $2\frac{7}{16}$ | $4\frac{1}{4}$ | $6\frac{5}{8}$ | ... | ... | ... | ... | ... | ... | ... | ... | ... | 16 |
| 17 | $1\frac{1}{4}$ | $2\frac{5}{8}$ | $4\frac{1}{2}$ | 7 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 17 |
| 18 | $1\frac{1}{4}$ | $2\frac{3}{4}$ | $4\frac{3}{4}$ | $7\frac{1}{2}$ | ... | ... | ... | ... | ... | ... | ... | ... | ... | 18 |
| 19 | $1\frac{3}{8}$ | $2\frac{7}{8}$ | 5 | $7\frac{7}{8}$ | ... | ... | ... | ... | ... | ... | ... | ... | ... | 19 |
| 20 | $1\frac{3}{8}$ | $3\frac{1}{16}$ | $5\frac{1}{4}$ | $8\frac{1}{4}$ | ... | ... | ... | ... | ... | ... | ... | ... | ... | 20 |

Finally the Committee, although recognising a departure from theoretically correct principles, advised that the lower rail should not be depressed. *Ballasting.*—The Committee state that the materials which best fulfil the requirements for ballasting are broken stone, gravel, coarse sand, burnt clay, partially disintegrated rock, slag, and cinders, and various products resulting from the separation of ores. Recommendations for depth of ballast give a minimum of 8 in., with an average of 12 in. Minimum dimensions for cross-sections are assigned to rock ballast and maximum to light materials such as coarse sand in which the sleepers or ties should be buried. Burnt clay formed a leading topic in the ensuing discussion, the trend of opinion being that it formed a good ballast when pure clay, free from sand or vegetable matter, was obtainable. One ton of coal produced from 4 to 4⅜ yards of good ballast. *Supply and Life of Cross Ties.*—American railroads have only recently commenced to treat their ties. In recommending trials, on a small scale, of that various timber preserving processes the Committee draws special attention to the cheaper varieties of petroleum which although not an antiseptic itself may possibly be rendered so by the addition of other substances. *Rails.*—This Committee confined their deliberations to the subjects of rail sections and specifications. It was urged that much better rails than are at present being made could be turned out from the steel now in use, provided it received the proper treatment in rolling. The bad effects arise from the use of a too high finishing temperature, which simply changes the form of the mass without changing its structure. A standard specification for steel rails was brought forward and recommended for adoption, the chief feature of which is the drop test. This is to be made on a piece of rail not more than 6 ft. long, the test piece being taken from the top of the ingot and placed on solid supports 3 ft. apart. The following impact tests to be made with a drop test machine having a tup of 2,000 lbs. weight, with an anvil block of at least 20,000 lbs. :—

| Weight of rail per yard | 45–55 | 55–65 | 65–75 | 75–85 | 85–100 lbs. |
|---|---|---|---|---|---|
| Height of drop ... ... | 15 | 16 | 17 | 18 | 19 feet. |

If any rail breaks when subjected to this test, two additional tests to be made with other rails from the same blow of steel, and if either of these fail all the rails of the blow to be rejected. The report also mentions that the Pennsylvania Railroad advocates higher carbon percentages than have been hitherto used, as the drop test shows that rails finished at a lower temperature give a greater deflection than those finished at the higher. C. E. A.

**1471.** *Concrete-steel Bridges for Inter-urban Railways.* **D. B. Lutin.** (Street Rly. Rev. 20. pp. 137–139, March, 1902.)—The author considers the various systems of reinforced concrete in vogue in the United States. Although concrete has been used extensively in recent years for bridge abutments, arches, and culverts, the use of concrete-steel results in a more reliable and efficient structure. Furthermore, as concrete is a more economical material than steel for transmitting compressive stresses, so steel is more efficient for transmitting tension ; a combination of the two materials in such structures as flat floor arches or girders where the steel is embedded in the concrete is very effective. In the Melan system I beams curved to follow the central axis of the ring are bedded in the concrete at intervals of 3 or 4 ft., while in the Thacker system pairs of bars are used, one being placed close to the inner edge of the arch rib and the other close to the outer edge, both being spaced laterally at intervals of 3 or 4 ft. In the author's system, which consists of a single series of steel rod or bar reinforcement, the principle that steel is not economical in compression is taken advantage of, to retain only those parts of the rods that are in tension. The amount of material saved by the use of a steel reinforcement is 60 per cent. C. E. A.

**1472.** *Re-rolling Worn-out Rails.* (Railroad Gazette, 34. pp. 174–176, March 14, 1902.)—The process described is carried out under the patents granted to E. W. McKenna. The charge for re-rolling rails is from 5 to 6 dollars a ton. The re-rolled rails have the same height as the original rails, but a smaller section. The worn-out rails are first re-ground, if necessary, and then heated in specially designed reverberatory furnaces, each of which takes an average charge of 20 rails, 30 ft. long. Some drawings are given showing the sections of a rail, which was re-rolled four times. The process appears to have been previously described in some detail in the Railroad Gazette, August 2 and 16, 1895. W. H. S.

**1473.** *Electric Car Equipments.* **A. W. Wigram.** (Inst. Elect. Engin., Journ. 31. pp. 668–671, March, 1902. Abstract of paper read before the Newcastle Section, Dec. 16, 1901.)—The ordinary hand brake leaves little to be desired, though the application of power by a direct pull tends to bend the platform. Some method should be adopted by which the strain is, as far as possible, confined to the truck. The best form of springs for the brake blocks is a helical one, about 8 in. long, having an extension of 1 in. for 70 lbs., and ⅜ in. adjusting bolts. Slipper brakes and electromagnetic brakes are recommended : but rheostatic brakes are undesirable, as they throw too much strain on the motors and resistances. Sanding gear is often unsatisfactory. It should be arranged so as to be worked by the left foot of the driver. Sand is often necessary in very dry weather; so much so that a car running at 8 or 10 miles an hour will slide on for 100 or even 150 yards if the emergency brake is applied without sand on a very dry track, the wheels being almost locked. The best form of trolley wheel is one having a wide groove, with a shallow depression in it equal to the diameter of the trolley wire and half its depth. Graphite bushings should be frequently oiled; in this way their life is increased by about 40 per cent. Trolley standards should be securely fastened to the roof of the car; if there is a wide side reach and the trolley wire is at all slack, the fastenings are apt to be loosened unless precautions have been taken to resist a side strain. W. H. S.

**1474.** *Brakes and Safeguards for Electric Tramways.* **Seefehlner.** (Zeitschr. Elektrotechn., Wien, 20. pp. 161–168, March 30, 1902.)—The author reviews critically the different protecting systems now in use in various countries to prevent accidents from electric tramcars in motion. After considering the mechanical construction of most of the safeguards used, the author thinks that the problem is not as yet satisfactorily solved, and points out that only in conjunction with properly constructed brakes can good results be obtained. A detailed description of most of the brakes used is given, and the importance of the electric brake in all its forms of construction and application is emphasised. The paper is fully illustrated, showing the safeguards and brakes now in use. L. G.

**1475.** *Electromagnetic Tramway Brakes.* (Schweizerische Blätter für Elektrotechnik, 7. pp. 35–37, March 8, and pp. 44–46, March 22, 1902.)—This is an illustrated description of the various forms of electromagnetic brake manufactured by Siemens & Halske. They include different kinds of friction-plate brakes, and also a solenoidal brake, the plunger of which is connected to the levers, which are ordinarily operated by the hand-brake. W. H. S.

**1476.** *Electrolysis by Earth Returns.* **R. Ulbricht.** (Elektrotechn. Zeitschr. 23. pp. 212–215, March 13, 1902.)—The author considers mathematically the values the stray currents derived from the working of electric railways, having the rails as returns, can attain, and their influence upon any metallic pipes running either parallel or transversely to the line of direction of the rails. The author takes a few typical cases for his calculations, and, from the formulæ obtained, makes some general deductions, which tend to explain the actions taking place in practice. For instance, the electrolytic action is increased, and the depth at which the metal is affected becomes greater when the current acts upon a smaller metallic surface; the total loss of metal is, however, larger if the action of the current is distributed over larger surfaces. Badly insulated pipes show the electrolytic effect more markedly on those parts where the insulation is worst. In order to avoid this, the pipes have to be either very heavily coated with an insulating material, which is an expensive and cumbersome method, or preferably, as suggested by the author, the electric conductivity of the pipe may be interrupted by the intercalation of insulating pieces which act as joints, sockets, &c., the construction of which require some further consideration. The paper is quite mathematical in all its bearings, and the conclusions derived are of a general character, so as to indicate the actions which take place when metallic pipes are in close proximity to, or further from, the rails, and also the means by which these effects can be diminished. L. G.

**1477.** *Herman's Automatic Electric Semaphore.* (Railroad Gazette, 34. pp. 178–179, March 14, 1902.)—This instrument is designed to work three-position signals such as those referred to in Abstract No. 996 (1901); it is, however, suitable for any other types of signal. The rod through which the semaphore arm is operated is connected to a sector which is capable of oscillating freely about the main shaft of the instrument, and the parts are so arranged that, when the sector is free, the semaphore arm moves to its "stop" position. The sector is provided on its periphery with a series of notches corresponding to the several positions in which it is to be secured, these notches co-acting with a locking bolt actuated by a high-resistance electromagnet through a compound toggle lever. The sector is moved by means of a main clutch wheel mounted concentrically thereto and driven by an electric motor through a train of spur gearing. The said clutch-wheel has a series of V-shaped recesses for engaging with the bolt of an electromagnetic clutching device, which is of similar construction to the locking device above mentioned, and is mounted on the sector, the electromagnet in this case being of low resistance and coupled in series with the motor. The current is controlled by switch contacts mounted on the moving parts. The current required is 1·6 amperes at 12 volts. One of these instruments has been making 500 movements per day for seven months without a failure, the consumption of current per day being 6·6 ampere-hours. C. K. F.

## ELECTRIC LAMPS AND LIGHTING.

**1478.** *Discussion on Improved Apparatus for Arc-light Photometry.* (Amer. Inst. Elect. Engin., Trans. 19. pp. 313–320, March, 1902.)—Referring to the paper by **C. P. Matthews** [see Abstract No. 623 (1902)], **C. H. Sharp** wished to know whether the author could not make use of a reduced copy of the apparatus described, for the determination of the mean spherical candle-power of the incandescent lamp by means of one measurement; and also whether he could not do away with the rotating sectored disk, replacing it by a simpler means of cutting down the intensity of the light. **C. P. Matthews** in reply said that it is quite possible to cut down the light effectively by means of the smoked glass, as he has done so with success. A miniature device for incandescent light photometry has also been used by him, but he is bound to spin the lamp in order to obtain the mean effect. **C. J. Spencer** asked what difference exists between the distribution of candle-power in alternating-current and direct-current lamps. In answer to this, the author referred to the published report of the National Electric Light Association, which dealt elaborately with that point [see Abstract No. 1001 (1901)]. **G. T. Hanchett** said that, instead of the flat pieces of glass used by the author in order to make the sigma equations as nearly as possible represent the integrals, he would suggest making a mirror which should be the frustrum of a cone instead of the frustrum of a pyramid. To that suggestion the author pointed out the difficulties which would be encountered, and also the objection that, as soon as one departs from the plane mirror, one gets a focussing mirror, and what is measured is, in that case, not the intensity, but the flux of the light. The number of plane mirrors used cannot be increased above a certain size without increasing the diameter of the ring, which is a serious objection. **C. H. Sharp** pointed out another difficulty connected with **Hanchett's** proposition, viz., that of smoking the glass to the requirements of the apparatus. **C. P. Steinmetz**

preferred to obviate, by the use of a simpler method, the necessity of having the screen smoked exactly to a certain intensity of absorption, which he considers a very delicate operation; and he asked whether the mirrors could not be replaced by white surfaces to measure the illumination as a secondary source of light, that is, instead of reflecting mirrors, to have a circle of white disks, and measure the total illumination coming from these disks? **C. P. Matthews** said that, although the suggestions were feasible in part, the method would be more complicated than the original one suggested by him, and gave reasons for this. **C. H. Sharp** concurred in the author's remarks. To the questions asked by **Hanchett** about the mean diameter of the frustrum of the pyramid forming the mirrors, and to **Woodward's** question whether any attempts have been made to obtain a self-registering record, and whether the selenium cell could not be used for it, the **Author** replied that the diameter is about 6 ft.; and as for the selenium cell, attempts have been made, but the selenium cell and photographic effects, and all other effects, differ from the physiological effect, and therefore he thought that there will never be anything else than the human eye to fix those values. **A. E. Kennelly** (communicated) emphasised the advantages to be derived from such apparatus in measuring the mean spherical candle-power in one operation; and pointed out that, although in the comparison of light sources, the spherical candle-power is the only reliable basis, at the same time it seemed doubtful whether it would be advisable to rate lamps commercially in terms of spherical candle-power, because it would diminish incandescent lamp ratings about 15 per cent., and arc-lamp ratings about 50 per cent. It would seem preferable to refer spherical candle-power measurements to the amount of light emitted. Since a unit spherical candle-power represents $4\pi$ lumens of light emitted, a spherical Hefner means 12,566 Hefner lumens emitted, a spherical British candle-power 12,566 British lumens, and so on. Similarly, an arc lamp of 1,200 maximum British candle-power, instead of being rated as of, say, 600 mean British spherical candle-power, would be a lamp of 7,540 British lumens, and if consuming 450 watts, its light efficiency would be 1,675 British lumens per watt. L. G.

**1479.** *The Heany Enclosed Arc Lamp.* **E. Trier.** (Elect. World and Engineer, 39. pp. 437–438, March 8, 1902.)—This lamp, which is the invention of J. A. Heany, of Philadelphia, presents a number of novel features, viz.:—The frame consists of two plates in the form of equilateral triangles, having the angles joined by rods on which slides the regulating solenoid by means of eyes fitted with set-screws so that it can be moved up or down to adjust the length of the arc. The solenoid is wound with bare wire insulated with asbestos-cord between adjoining convolutions and sheets of asbestos between successive layers, so as to reduce the liability of burning out to a minimum. The upper carbon is secured at its upper end to a cap connected by a flexible conductor to the supply conductor, and slides in a brass tube forming a central member for the lamp frame. The core of the regulating solenoid is formed by the two halves of a longitudinally slit tube, which halves slide over the central frame-tube inside the regulating solenoid, and are hinged together at their lower ends. The clutch-jaws form downward extensions of these halves, and extend through apertures in the central frame-tube to engage with the upper carbon. When the solenoid is de-energised, these jaws fall on to a fixed cone and are thus separated; when, however, the solenoid is energised, the halves of the core-tube repel each other by reason of their being of like polarity, and cause the jaws to grip the carbon before lifting it in striking the arc. The magnetic field is strengthened by placing a shell of soft iron around the solenoid. The combined clutch and core is connected to a dash-pot through the pin of one of the hinges above mentioned. C. K. F.

1480. *The Regina Enclosed Arc Lamp.* **B. Donath.** (Elektrotechn. Zeitschr. 23. pp. 220–221, March 13, 1902.)—In this paper further description and tests are given of this lamp, of which some particulars have already been given in Abstract No. 1011 (1902). These lamps differ from the previous types of enclosed arc lamp in that the carbons are not guided through stuffing-boxes, but are shut off from the external air by the inner globe and the body of the lamp. The supply of oxygen is regulated by special means, not described. Calling the actinic power obtained from a Regina lamp, of 220 volts and 3 amperes, unity; with a similar lamp of 110 volts and 6 amperes, it was 1/2·6; with an open lamp of 55 volts and 12 amperes, 1/4·4. The light from a window (January, 12 o'clock, blue sky) was 1/5·4; and that from a window (January, 12 o'clock, clouded sky) 1/9·1. An open arc lamp of 55 volts and 6 amperes gave 1/9·0. The actinometer was placed 40 cm. away from the lamps provided with white globes. At this distance, the 220 volt and 3 amperes lamps corresponded in its actinic action to that of the light of midday in July, so that it is extremely useful for photographic purposes. Barium platinum cyanide is lighted up intensely. The spectrum shows three main groups of lines, of which the first is intensely blue, the second clear violet, and the third dark violet. The discharge in the enclosed space approximates to that in a slightly exhausted Geissler tube. C. K. F.

1481. *Crawford Voelker Incandescent Lamp.* **T. C. Crawford** and others. (Elect. Rev. 49. pp. 1038–1039, Dec. 20, 1901, and 50. p. 13, Jan. 3, 1902.)—Correspondence, in which attention is drawn to the fact that the published results of recent tests on this lamp [see Abstract No. 624 (1902)], are of little value, because the c.p. and voltage are not stated. W. R. C.

## REFERENCES.

1482. *High-Tension Electric Power Transmission.* **G. H. Gibson.** (Eng. Mag. 3. pp. 75–89, April, 1902.)

1483. *Electricity in Greece.* **F. W. Jackson.** (Cassier, 21. pp. 443–455, April, 1902.)

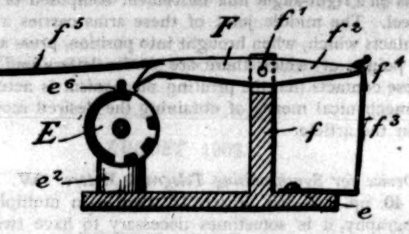
1484. *Montmorency Falls Power Plant.* **F. C. Perkins.** (Elect. Engin. 29. pp. 510–511, April 11, 1902.)—The article contains a general description of the station, which supplies power for the lighting and tramways of Quebec. [See also Abstract No. 285 (1901).] W. H. S.

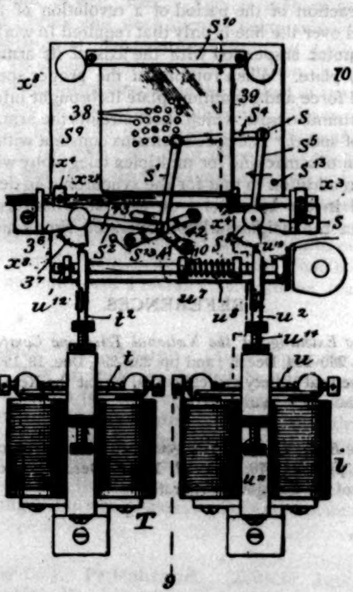
1485. *Power and Lighting Plant of the Chicago University.* (Eng. Record, 45. pp. 245–248, March 15, 1902.)

1486. *Chilled Cast-iron Car Wheels.* (Railroad Gazette, 34. p. 227, March 28, 1902. Extracts from an address delivered before the Engineering Students of Pardue University by Mr. C. H. Vannier, of the Griffin Wheel Company, Chicago.)—A descriptive account is given of the origin, development, and modern processes of manufacture of chilled cast-iron car wheels. C. E. A.

## TELEGRAPHY AND TELEPHONY.

**1487.** *Gilmore Automatic Printing Telegraph System.* (West. Electn. 30. pp. 189–191, March 22, 1902.)—The sending typewriter is so arranged that when a key is depressed it moves a contact lever appropriated to the particular letter so that it comes into contact with metal surfaces representing dots and dashes of the Morse code. These surfaces are mounted on insulating fibre, and occupy regular spaces along the signal shaft. The first diagram shows the arrangement for the letter "B." The lever is held up until the key is depressed by the catch at one end. After one revolution of the shaft, the little fibre projection raises the lever again to its position of





rest. The shaft does not revolve continuously, although the electric motor which actuates it is constantly running, but the depression of any one of the key levers throws in a clutch between the motor and the signal shaft, thereby causing the latter to revolve. The shaft releases itself from the clutch at the end of each revolution, and all parts are left in their normal condition. At the receiving end, the long and short impulses operate two separate relays. This is accomplished by a system of retardation winding and condensers. As shown in the second diagram, two magnets in the relay circuits operate escapements on a right-angle link movement composed of four light forked arms of steel. The middle joint of these arms carries a series of spring-pressed contacts which, when brought into position, press against a "group" of contact points, of which there are 40 for letters and numerals. It is through these contacts that the printing mechanism is actuated. The electrical and mechanical means of obtaining the desired movements are fully described in the article. E. O. W.

**1488.** *Device for Synchronising Telegraph Motors.* **W. Duane.** (Elect. Rev. N.Y. 40. pp. 357–358, March 15, 1902.)—In multiplex, printing, and picture telegraphy, it is sometimes necessary to have two drums rotating synchronously at each of two stations. The device described enables this to be done through the two wires or through the wire and earth return connecting the two stations. The circuit is used for synchronising purposes only during a small fraction of the period of a revolution of the drum, and the power transmitted over the line is only that required to work a sensitive relay. It consists of a motor suspended with the axis of its armature vertical, and resting on a steel plate. When rotating at the proper speed an arm swings out by centrifugal force and a platinum plate its brought into contact with the platinum-tip of a thumb-screw, which short-circuits the armature and prevents further increase of speed. The speed remains constant within half a per cent. A picture is shown of a machine for multiplex telegraphy with 18 segments in the commutator in addition to that for the synchronising device. It has been successfully tried in the laboratory of Colorado University over eighteen distinct circuits in the neighbourhood operated simultaneously. A. R.

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**1489.** *Telephone Exchange of the National Telephone Company at Kensington.* (Electrician, 48. pp. 250–254, Dec. 6; and pp. 292–294, Dec. 13, 1901.)—Description of exchange system, central battery switchboards, &c., at the Kensington Exchange of the National Telephone Company. J. E. K.

**1490.** *Telephone Exchange of the Glasgow Corporation.* (Electrician, 48. pp. 333–337, Dec. 20; and pp. 374–378, Dec. 27, 1901.)—Description of exchange system, switchboards, &c., of the Glasgow Corporation. J. E. K.